

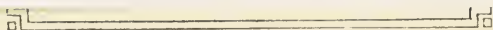


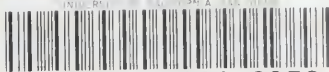
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THE
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ASSISTED BY A LARGE STAFF OF COLLABORATORS

FULLY ILLUSTRATED

Volume XVII
Toxic Amblyopia to Vertige Paralyant

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(Concluded from Preceding Volume)

Eserin. Consult p. 4521, Vol. VI of this *Encyclopedia*.

The *Ophthalmic Year-Book* for 1913 furnishes a number of cases of amblyopia due to eserin. For example in a case of corneal ulcer recorded by Wessely, instillation of one drop of a 1 per cent. solution of eserin for a slight intercurrent attack of glaucoma was followed within a half hour by severe symptoms of acute glaucoma. The visual acuity, which had fallen from 0.5 to 0.2 during the disturbance which preceded the instillation of eserin, was reduced to counting fingers at 2 to 3 meters, and the tension rose from 35 to 60 mm. Repeated instillation of homatropin in the course of a few hours led to disappearance of all glaucomatus symptoms, so that on the same day the vision had returned to 0.5. That the symptoms had been due to the eserin was demonstrated three days later, when instillation of a $\frac{1}{2}$ per cent. eserin solution produced another attack of glaucoma as sharp as the first. Wessely reproduces tracings of the changes of tension in rabbits' eyes under the influence of eserin. In every case there was a distinct rise, which began ten to fifteen minutes after the instillation and shortly after the appearance of miosis, reached its maximum in ten to fifteen minutes, and descended to the previous level one hour after the beginning of the experiment. Since it has been demonstrated on rabbits' eyes that eserin instillation is followed by hyperemia of the iris and ciliary processes, Wessely explains rare cases of paradoxical action of eserin, such as his own, as due to individual predisposition to hyperemia of the iris.

Bride's patient was a woman of 46 years, suffering from chronic glaucoma, who gave a family history of epilepsy although she had never had a seizure. After the use of eserin for six days, she had a number of epileptic seizures, which stopped some hours after the eserin was omitted and recurred eleven days later after inadvertent administration of the same miotic. Pilocarpin was well tolerated.

Esculin. See *Horse chestnut*.

Essence of ginger. *Jamaica ginger.* See p. 5386, Vol. VII of this *Encyclopedia*.

Essence of lemon. See p. 4524, Vol. VI of this *Encyclopedia*.

Ether. *Sulphuric ether.* See p. 424, Vol. I of this *Encyclopedia*.

When used as an anesthetic the pupillary signs are much the same as with chloroform, but Jacob noticed, six times, mydriasis instead of miosis in the stage of deep narcosis out of 1200 etherizations. As a result of a study of these signs Warner reports a disassociation of the usual binocular movements under chloroform which is not exhibited by ether. Detachment of the retina, probably as the result of efforts at vomiting, has been recorded by several observers, e. g., by Schirmer.

Ethyl bromid. See p. 4541, Vol. VI of this *Encyclopedia*.

Ethyl chloride. See p. 4541, Vol. VI.

Ethylene bromide. See p. 4542, Vol. VI of this *Encyclopedia*.

Ethylene chloride. Ethylene dichloride. An account of this poisonous "Dutch liquid" is given on p. 4542, Vol. VI of this *Encyclopedia*. To this may be added that this agent is used as an anesthetic, especially under the modified form of *ether anestheticus aranii*. Raphael DuBois noticed that after inhalations of it, dogs and rabbits acquired persistent opacities of the cornea. Panas believes these to be due to serious infiltration of the true substance of the cornea dependent upon a destruction of portions of Descemet's membrane by the ethylene chlorid. In this way the parenchyma is exposed to the action of the aqueous humor.

Ethylhydrocuprein. See **Optochin**, as well as under the same rubric in this section.

Ethyl nitrite. See p. 4544, Vol. VI of this *Encyclopedia*.

Ethylidenediamin. See p. 4544, Vol. VI of this *Encyclopedia*.

Eucalyptus oil. Consult p. 4545, Vol. VI of this *Encyclopedia*.

Euphorbia. See end of *Emetin*, in this section.

Face powder. Consult p. 5134, Vol. VIII of this *Encyclopedia*.

There is a foundation of truth in the statements made by a writer in *School Science and Mathematics* for October, 1914, who says that for several years occasional cases have come under the observation of oculists in which the patients, invariably women, complain of vision being blurred, inability to use the eyes for any length of time, and severe itching of the lids. The slightest rubbing of the lids produces a marked redness of the eyes and only aggravates the itching. In severe cases, the lids are frequently swollen from constant rubbing. There is a sticky, elastic secretion. Microscopic examination of the secretion reveals masses of what appear to be crystals. These crystals have been found to come from rice face-powder. Nine patients suffering from this form of conjunctivitis, all using the same make of face-powder, were observed in one university school.

Filix mas. Male fern. In addition to the matter to be found on p. 5198, Vol. VII of this *Encyclopedia*, Casey Wood (*loc. cit.*, p. 47) remarks that there are several well authenticated instances of amaurosis and amblyopia from acute poisoning by this drug. In a fatal case reported by Eich the symptoms were those of strychnia poisoning with contracted pupils. In some severe cases of poisoning when the patients survived, blindness, the result of optic nerve atrophy has been several times recorded. Schlier reports a case of temporary amaurosis complicated with albuminuria, but the history of several other cases reads like quinin amaurosis. Zimmerman records an instance of bilateral opticus atrophy from a dose of ten grams of the

extract, and Fritz of a unilateral atrophy following the acute blindness. Fritz's case is worth recording in full: A well-nourished girl, servant, aged 18, suffering from tænia, bought at a drug-store ten capsules of extr. fil. maris, each containing one gram, and took a capsule every hour. As soon as she had taken six she was attacked by convulsions and coma, and when she recovered from these was blind in both eyes and her pupils widely dilated. In the course of a week the sight in the right eye began to improve, but very slowly, until after several months the visual acuity again became normal. The left eye remained amaurotic and in it atrophy of the optic nerve was plainly made out. The papilla became very white and the eye was finally affected by strabismus.

J. Perrod (*Annali di Ottalmologia*, p. 17, 41, 1915; abs. by Antonelli in *Ophthalmoscope*, p. 147, Mar., 1915) narrates the case of a man of 25 years, who had taken, to cure ankylostomiasis, fifteen grammes of male fern in less than twenty-four hours. On the same day, in spite of a saline purgative, intoxication showed itself under the guise of headache, tinnitus, palpitations, vomiting, waves of heat, and agitation alternating with prostration. On the following day, after a sleepless night, the patient found himself to be completely blind. There was moderate mydriasis and no reaction of the pupils. No perception of light. Bilateral papillitis of moderate degree, with signs of stasis, but without hemorrhage or macular lesions. Despite general treatment and subconjunctival injections of sodium chloride and of sodium nitrate, post-neuritic atrophy supervened, and blindness became complete and definitive.

The author quotes from the work of Stuelp, Sidler-Huguenin, Zimmermann, Siegrist, etc., to insist upon the clinical forms of the ocular affection, upon its grave prognosis, and upon the danger of even moderate doses of oil of male fern. It would be wise to replace this vermifuge by large doses of thymol, such as have been proposed in the treatment of ankylostomiasis by Bozzolo and Graziadei.

Antonelli notes in this connection a fact mentioned by Perrod: the optic discs of this patient, especially that of the right eye, showed in the atrophic period, "some small heaps of pigment collected on the nasal border of the optic papilla." This new formation, or migration of pigment consecutive to a papillitis (papillitis of moderate intensity and without hemorrhages), goes to confirm, by an absolutely objective case, the value of the "*cadre pigmentaire*," total or partial, that we have described as posthumous of neuritis, or neuro-retinitis, among the rudimentary ophthalmoscopic stigmata of congenital syphilis. The value of this sign has been contested, notably by Wecker and Masselon, who desire to bring it into line with the pigmented choroidal

creescent—a physiological detail. But there is a clear difference in the disposition and ophthalmoscopic aspect between the choroidal ring and the “cadre,” or sector of the “cadre pigmentaire” around the papilla.

Fish poisoning. Consult p. 5208, Vol. VII of this *Encyclopedia*; see, also, *Botulism* herein.

Food, Decomposed. See *Botulism* herein.

Fuchsin. See *Anilin* and *Dyes* herein.

Fungus poisoning. Under several headings this subject has been discussed here. It may further be said that manifestations of this form of intoxication naturally depend upon the kind of fungus, since the active agents in the various mushrooms, toadstools, etc., vary greatly. Some of them when eaten in poisonous doses produce accommodative spasm and contraction of the pupil, only, as Knies points out, these symptoms occur in order the reverse of those brought about by eserine, the spasm coming on first. Such a fungus is the *agaricus muscarius* whose active principle—muscarin—closely resembles the ptomain named neurin. The *agaricus phalloides* on the other hand, does not affect the pupil, although, as Handford has shown, disturbances of vision result from poisoning by it. In Maurer's case the pupils were dilated *ad maximum*.

Gelsemium. See p. 5349, Vol. VII of this *Encyclopedia*. According to Ringer, *Gelsemium sempervirens*, when taken internally, may cause miosis, although it is a mydriatic when locally applied.

Gentian violet. Consult p. 5358, Vol. VII of this *Encyclopedia*.

Ginger, Jamaica. See p. 5386, Vol. VII of this *Encyclopedia*; as well as under *Columbian spirits* herein.

Hair dyes. Consult p. 4100, Vol. VI of this *Encyclopedia*.

Hashish. See *Cannabis indica* in this section.

Helvella esculenta. See p. 5755, Vol. VIII of this *Encyclopedia*.

Heroin. See p. 5880, Vol. VIII of this *Encyclopedia*.

Homatropin. See the major heading **Homatropin**, in this *Encyclopedia* where the possible production of glaucoma by this drug is discussed. As an instance of this oculotoxic effect, in a case reported by Stevenson (*Oph. Year-Book*, p. 36, 1913) the eye of a man, aged 23 years, developed glaucomatous symptoms a day after two drops of homatropin solution, 4 gr. to the ounce, had been instilled following removal of a foreign body from the cornea. The vision of the eye was reduced to counting fingers. The tension became normal after three instillations of eserine at intervals of a quarter of an hour, and the eye had completely recovered by the following day. Both eyes were hyperopic 4 D., with some hyperopic astigmatism.

James A. Craig (*Br. Journ. Ophthalm.*, p. 250, June, 1919) records

a case of homatropin poisoning in which there was probably a marked idiosyncrasy towards either the homatropin in the solution employed or some impurity in the drug.

The patient, *æt.* $5\frac{1}{2}$ years, had, two years earlier, her refraction determined after atropinization. On this occasion, a solution of sulphate of atropin, gr. 4 to $\bar{5}$ 1, had been dropped into each eye twice daily for three consecutive days. There was then no symptom whatever of belladonna poisoning, so that it may safely be assumed that the patient had no undue susceptibility to atropin.

On her return two years later for re-examination, it was considered sufficient to use homatropin. A drop of the solution, 4 gr. to $\bar{5}$ 1, was instilled into each eye, and the child was allowed to go out with her mother to visit some friends in the immediate neighborhood, with instructions to return in an hour. When she did return—two hours later—the cause of the delay was sufficiently obvious. The child was in a condition of intense mental excitement, laughing, talking incoherently, and with hallucinations of vision. She also complained of dryness of the mouth. As examination was out of the question she was sent home. The excitement continued without abatement until 3 o'clock in the following morning (*i. e.*, ten hours), when she fell asleep. On waking five or six hours later, her condition had become normal.

The same solution, the writer continues, has been frequently used since. In the majority of cases, the patient has been conscious of no unusual general effects. In one or two, however, there has been produced a slight sensation of giddiness, together with some dryness of the mouth. This would suggest that impurity of the drug, may, in some degree, account for the facts of the case presented.

Horse chestnut. Esculus hippocastanum. The active principle is esculin, a white, bitter, crystalline glucoside, obtained from the bark: dose, 15 grs. in malaria.

Salomon describes the eye symptoms produced in a boy, $3\frac{1}{2}$ years of age, from eating the green rind of fruit. They resemble those of atropia poisoning—widely dilated pupils, staring vision, scarlet face, bounding pulse, etc.

Hydrocyanic acid. Prussic acid. Oculotoxic symptoms are rare from this otherwise powerful poison.

H. de Tatham reported, as the result of exposure to the vapor of dilute hydrocyanic acid, a temporary hemianopia, that disappeared in a few hours. G. F. Souwers, in a photographer poisoned by potassic cyanid, remarked swelling of the upper lids and sluggish pupils. Müller-Warneck saw completely dilated pupils, with absent irritation

reflex and proptosis, in a case of intoxication from cyanid of potassium; the patient recovered.

Hydracetic. There is a history of this agent causing in one eye small retinal hemorrhages, attributed by Grünthal to inunction of salve containing the drug; the urine contained much albumen.

Hyoscin. Consult p. 6091, Vol. VIII of this *Encyclopedia*. See, also, *Scopolamin* herein.

Hyoscyamin. See p. 2200, Vol. III; as well as p. 6093, Vol. VIII of this *Encyclopedia*.

Iodism. See, chiefly, p. 6566, Vol. IX of this *Encyclopedia*.

Edema of the lids as in Hewkley's case, accompanied by lachrymation and pains in the eyes, as seen in the case of Lorenz, constitute the ordinary symptoms of ocular iodism, as part of a general intoxication.

Iodoform. For some of the oculotoxic effects of this drug, consult p. 6569, Vol. IX; as well as p. 9047, Vol. XII of this *Encyclopedia*.

de Schweinitz gives the following complete account of this form of ocular intoxication:

General iodoform poisoning has been divided into six varieties, characterized by various symptoms—fever, gastro-intestinal irritation, and peculiarities in the circulation, especially a rapid and soft pulse. In some cases the phenomena resemble meningitis, namely, contracted pupils, restlessness, headache, active delirium, stupor, and death; in others, cerebral congestion. Fatty degeneration is a prominent pathological lesion.

Although iodoform was discovered in 1822, it was not until 1882 that a case of toxic amblyopia attributed to this drug was recorded; by Hirschberg (*Centralbl. f. prakt. Augenheilk.*, 1882, vi., p. 92). Four years later E. Hutchinson (*N. Y. Med. Journ.*, 1886, xliii., p. 16), of Utica, N. Y., described a second case, and Priestley Smith, (*The Ophthalmic Review*, 1893, xii., p. 101) in England, and Valude, (*Annales d'Oculistique*, 1893, cix., p. 378) in France, added two cases to the literature.

As is well known, many of the cases of general iodoform poisoning have resulted from its absorption after it was sprinkled over wounds of large area, hence in the toxic amblyopias arising under its influence a similar source of entrance into the economy might be expected. This is true in Hirschberg's and Valude's cases, but in Hutchinson's and Priestley Smith's patients the toxemia followed the absorption of iodoform pills, in the former instance associated for a time with the administration of creosote. The latter drug, however, was proven to have been without effect upon vision.

Two of the four patients were young, Valude's case being a child of twelve years. The other two were adult males, Priestley Smith's patient being thirty-one years. The age in Hutchinson's case is not given.

The influence of tobacco or alcohol was practically excluded in Hutchinson's case; his patient did not smoke, and drank only a little wine at dinner, while Smith's patient was not an excessive smoker. Moreover, the rapid onset of the amblyopia occurred seven weeks after he had discontinued smoking. The other two patients, namely, those of Hirschberg and Valude, both girls, one sixteen years and the other twelve years, are not likely to have come under the influence of either tobacco or alcohol. Hence it may be fairly assumed that the disturbance of vision in these cases was the result of the toxic influence of iodoform.

The quantity necessary to produce amblyopia appears to be considerable; thus, Smith's patient consumed 1000 grains in forty-one days, and then toxic symptoms appeared. The daily dose of iodoform in Hutchinson's case was 9 grains, begun in June, 1884, and continued until the following February. During this time 6 grains of creosote were also daily consumed. In the other two cases it would be difficult to estimate the amount of iodoform, as the absorption was through an abraded surface.

The symptoms vary in the several cases which have been reported, but all appear to have one in common, namely, marked reduction of central acuity of vision. The vision of Hirschberg's patient was $1/20$ and $1/30$, of Hutchinson's $1/100$, and of Priestley Smith's $6/30$ and $6/24$. In Valude's case the vision was extremely bad, owing to atrophy of the disks.

Hirschberg (*Berlin. Klin. Wochenschr.*, p. 636, 1882) has given the following history: A sixteen-year old girl was operated upon by Prof. Küster for hip-joint disease which was dressed with iodoform. During the after-treatment severe disturbances of vision set in. V. R. = $1/20$, V. L. = $1/30$. There was a central scotoma of from 4° to 8° radius, otherwise the field of vision was undisturbed. Fundus entirely normal. Pupils widely dilated. Hirschberg diagnosed iodoform amblyopia. In eight days vision was again normal. Nothing is said in this report about the patient's smoking or drinking habits.

The pupils may be widely dilated and sluggish in their reactions. Exact observations of the effect of this drug on accommodation have not been recorded.

In one case the ophthalmoscopic appearances were normal; in another the disk appeared grayish-white, somewhat resembling that

seen in tobacco-amblyopia; in a third there was haziness of the nerve-tip's margin, but no pronounced papillitis, while in one instance there was atrophy of the papilla.

The field of vision has been reported normal and the color-perception good, but in each of the two best studied cases (those of Hirschberg and Priestley Smith), there was a bilateral central scotoma, in the former from four to eight degrees radius, and in the latter well-marked and absolute for white paper at or near the fixation point. Otherwise the visual field appeared to be intact.

Hence we may expect in typical iodoform-amblyopia marked reduction of the central acuity of vision, unimproved by glasses; preservation of the peripheral visual field, but a central scotoma at or near the fixing point; and negative ophthalmoscopic appearances, or, at most, some grayness of the disk with blurring of its margins. True, complete atrophy is reported in one instance, but, as will be seen from the abstract of the case, it is by no means certain that iodoform was responsible for the visual conditions. The close analogy between this disease and a similar affection arising under the influence of tobacco and alcohol will be readily recognized.

The diagnosis must of course be based upon the history of the case, i. e., long-continued internal administration of iodoform, or the use of the powder over an extensively abraded surface, in connection with the visual disturbance. There are no distinguishing features in the visual phenomena upon which to rest an absolute diagnosis.

The prognosis, if Valude's case is excluded, is good, provided the patient is freed from the influence of the drug which has created the defect in vision.

The duration of the amblyopia depends somewhat upon the quantity which has been taken and absorbed. In one case restoration occurred in eight days, while in another nearly three months elapsed before the central scotoma disappeared.

Judging from clinical symptoms this form of amblyopia should be relegated to those of peripheral origin, and probably depends upon some influence of the drug on the fibres of the papillo-macular bundle, analogous to the effect of tobacco, lead, alcohol, and other poisons.

It is not without interest to recall in this connection that iodoform is broken up in the system into iodic acid and iodine, and that Binz believes that it is the latter ingredient which influences the general nutrition. Furthermore, it is one of the drugs which, in a pronounced degree, has the power, in toxic doses, of producing fatty change in the various tissues of the body.

Treatment consists, first, in the separation of the patient from all

possible influence of the drug. Internally, strychnin appears to have been of the greatest service, and should be administered, as in other toxic amblyopias, by the hypodermic method. General anemia, which is not unlikely to be present, may be combated with iron. Should actual atrophy of the disk supervene, the usual measures, alterative and stimulating, may be tried. Two of the cases were promptly relieved by the strychnin treatment.

Ioduret. See p. 6574, Vol. IX; also, p. 9047, Vol. XII of this *Encyclopedia*.

Lead-poisoning. Saturnism. Plumbism. Lead encephalopathy. The ocular relations of this subject are discussed under many headings in this work, but especially on p. 2200, Vol. III, and on p. 8342, Vol. XI. See, also, **Retinitis, Saturnine**. It may be necessary to repeat some of this information here while at the same time adding to it.

Smetius in 1611 was the first to report a case of lead amblyopia. In 1839 Tanquerel recorded several cases and wrote rather extensively on the subject. In 1905 Lewin and Guillery collected 142 cases of lesions of the ocular apparatus due to lead-poisoning. Lead amblyopia may or may not be attended with changes recognizable with the ophthalmoscope. The amblyopia may be sudden or slow in its onset. It may be transient or permanent. It may occupy all or a portion of the field of each eye. The transitory amblyopia is supposed to be due to the anesthetic poisoning or to ischemia due to vasomotor spasm. The more permanent form is explained by the direct and permanent action of the metal upon the nervous elements of the optic tract and the sclerotic changes in the bloodvessels resulting in ischemia or hemorrhage. Pathologic examination has shown cerebral hemorrhage, obliterating endarteritis, thrombosis and embolism. Hemianopsia is among the unusual manifestations, as but 7 cases are to be found in the literature.

Carl Williams (*Prac. Med. Series, Eye*, p. 112, 1912) reported one case of a man, aged 52, of temperate habits who went to work in a lead shop where he was exposed to lead fumes. Within five weeks he developed lead-poisoning. After a month's treatment in the hospital he was discharged as cured. He returned to his position in the lead works, but after two weeks was again taken ill and again admitted to hospital with lead-poisoning. He was again discharged after a month's treatment as cured. He was admitted again to the hospital a month later and placed in the insane department and his condition treated for seven months as one of toxic confusional insanity, due to encephalopathy. At the latter end of this period his eyes presented the following condition: O. D. V. = 6/ix. O. S. V. = 6/xiii. The media

were clear, the discs slightly blurred at the margins and pale on the temporal sides. No gross changes were observed. Examination of the fields showed a left homonymous hemianopsia without involvement of the fovea in either eye. Wernicke's test showed a normal pupillary reaction.

Wood (*loco cit.*, p. 41) claims that the symptoms of this form of amblyopia are by no means constant because plumbism does not always affect the same parts of the eye. Among the earliest and most interesting contributions to this subject is the account given by Mr. Hutchinson of five cases.

The commonest symptoms are those due to optic nerve atrophy which may come on slowly or be chronic from the beginning. The picture is usually that of a pale, well-defined disc with the arteries greatly reduced in caliber, even when the veins are distended. Sometimes there is slight congestion of the papilla, but this is accompanied by little swelling, and the disc eventually becomes of a dirty-gray tint with lines running along the narrowed vessels. Sight is always greatly affected, and the visual field may present both central and peripheral defects. This commonly goes on to total blindness. In five cases published by Landesberg, two had optic nerve atrophy and treatment was of no avail. Vision was reduced to 20/100 and less in both eyes.

In a case described by Unthoff, a color-mixer, aged 18, seen nine months after symptoms set in, not complicated by tobacco, alcohol, or renal affection, there appeared to be an extensive retro-bulbar neuritis. The vision in the right eye was only 7/200 and in the left eye 8/200. The F. of V. showed an absolute central scotoma with uncontracted periphery. There was a distinct pallor of the outer half of the disc. Very little improvement took place. deWecker and Masselon speak of true retro-bulbar neuritis as common in cases of lead-poisoning, but say that if the poisoning persists the relative scotomata become absolute and increase in size.

In another and important class of cases the local manifestations are those of a decided optic neuritis with retinal and papillary hemorrhages, swelling of the disc, tortuous and obscured vessels. Gowers figures such a fundus in the case of a man, aged 45, who had marked cerebral symptoms—severe headache, delirium, convulsions, etc. The disc was concealed by a swelling of moderate prominence bordered by a fringe of striated hemorrhage and of a color nearly that of the fundus. The veins a little larger than normal. Arteries concealed by the swelling and most of them very narrow. Vision was considerably impaired but could not be accurately tested, owing to his mental state.

Last, but by no means least, there may exist a state of transient visual disturbance without fundus changes, which is probably the most frequent of all. The amblyopia may last but a few hours, and many patients who finally exhibit signs of optic atrophy or neuritis give a history of antecedent "attacks" of dim vision. Gowers thinks this is analogous to the temporary amaurosis of diabetes, and is due to the direct effect of the lead upon the visual centers.

Stricker records a well-marked example of temporary amblyopia in which, however, the attacks lasted much longer than they usually do. The patient, a woman, had intermittent epileptiform attacks due to lead-poisoning. These were accompanied by a slight bilateral optic neuritis, giving rise to a sensation of fog before the eyes. For varying periods the vision sank so low that she could not see her hand. In the intervals of rest from the fits the cloudiness cleared up and the patient had normal acuity of vision. At one time the foggy sight lasted nine weeks, but eventually the attacks of saturnine epilepsy became less frequent and less severe, and with this improvement the optic disc again resumed its normal aspect. In the same way Günsburg relates a case of temporary blindness (in which the lead-poisoning had produced renal disease) associated with uremic symptoms. The loss of sight lasted several hours. The fundi were normal, but the pupils did not react to light. Next day V. was normal and the uremic symptoms had disappeared. Michel has observed in several cases of lead colic that the visual acuity temporarily diminished to mere perception of light although there were no fundus changes discernible. This state of things he considers a purely reflex amblyopia, and does not think it is due directly to the lead-poisoning.

In chronic lead-poisoning the general symptoms (characteristic dark line along the gums, colic, muscular paresis, arthralgiæ, etc.) usually persist for a long time before vision is affected. Samelsohn has pointed out, as a rare exception to this rule, the appearance of ocular affections before other signs of plumbism show themselves, and states that in such cases the former rapidly disappear when the poisonous influence is removed. In any event the eye is involved (seriously at least), in a very small percentage of cases of plumbism.

In Günsburg's case the patient was unaffected until after he had been employed continuously for 27 years in a lead works. If the injurious habit or occupation of the patient is persisted in, organic lesions commonly show themselves with a permanent reduction of vision.

Although the above forms include the great majority of cases of lead amblyopia, many other ocular manifestations are on record, espe-

cially paralysis of one or more of the extrinsic ocular muscles. One of Landesberg's cases had a bilateral paresis of the rectus externus; another had complete paralysis of all branches of the oculo-motorius. Von Schroeder also reports a case of typical neuro-retinitis with bilateral abducens paralysis. Landolt describes a most interesting case of left-sided hemianesthesia with gray-red discs and irregular scotomata in both fields.

Wadsworth gives a very instructive account of a boy, aged 9, with marked optic neuritis and paralysis of several ocular muscles; lead was found in the urine for many months and vision was entirely lost from optic atrophy. The source of the lead was not ascertained.

The state of the pupils, to which importance is attached by some in the diagnosis of the ocular disturbance of plumbism, is not of much importance. They are often dilated during attacks of colic, but may, according to T. Oliver, be unequally affected. Their condition at other times will depend upon the amount and kind of the fundus changes.

The diagnosis of lead amblyopia rests upon the presence of the accompanying plumbism, although when nephritic or cerebral disease is present it may indeed be difficult to say whether the ocular disease be due to the direct or the indirect influence of the lead-poisoning. There is no reason why the presence of lead salts in the body should not be demonstrated, and in all doubtful cases the urine should always be examined from time to time. C. A. Oliver relates a case of progressive blindness in a male adult where the urine, saliva and nasal mucus revealed the presence of lead.

The prognosis is favorable when vision is not reduced and the fundus changes are slight or are recent, but very unfavorable in chronic atrophy, in the retinitis accompanying nephritis and in the neuritis following or accompanying cerebral disease.

The *alterations in the ocular tissues* seen in plumbism have also been discussed by Wood (*loc. cit.*, p. 74). He pointed out that there are few autopsies recorded. In Atkinson's case no changes in the ocular apparatus are mentioned. The various manifestations of lead amblyopia probably correspond with very different morbid alterations in the tissues of the eye. In the mild forms, where there are no ophthalmoscopic appearances, one can but guess at the probable organic lesion. Gowers thinks that the transient amblyopia is caused by the effect of lead on the nerve centers, as in uremia and diabetes. Günsberg, who publishes a case of transitory amblyopia due to lead-poisoning, would class it among the uremiæ. He considers that the kidney affection is caused by the plumbism, which in its turn brings about a temporary disturbance of vision. Weber thinks that the

amaurosis is not due to kidney disease, but is a brain symptom. He explains the temporary amblyopia by regarding it as the result of arterial spasm and the over-filling of the veins—such a condition as is present in an attack of lead colic. These symptoms occur in a person but a short time exposed to the poison.

Long-standing cases of white atrophy, as well as those that show acute inflammatory neuritis (papillitis) with retinal hemorrhages are the result of nervous irritation set up by the circulation of lead salts in the system. So far as we know, the histological changes are those that accompany these diseases when due to other causes, such as diabetes, albuminuria and brain tumors. As we may have retinitis when no kidney disease is present, and optic atrophy without decided spinal or cerebral symptoms, it is not proper to regard the latter as only indirectly dependent upon the circulation of plumbic salts in the system. When two or more possible causes of the ocular affections co-exist in the same patient, their pathology is to that extent obscured. The local appearances of most examples of albuminuric and diabetic retinitis are, however, so pathognomonic and so different from the inflammatory fundus-changes seen in lead amblyopia that the question of causation does not often arise. The possible coincidence of brain tumor with lead amaurosis must also be borne in mind.

As the actual method of causation of any of these morbid states is still sub judice, it is idle to speculate about their origin in the comparatively rare instances furnished by lead-poisoning.

Parisotti and Molotti observed a case of optic nerve atrophy which after careful examination by the ophthalmoscope, they concluded was the result of an *endarteritis saturnina obliterans*. The oculomuscular pareses are undoubtedly the result (as in the paralysis of the forearm extensors) of a peripheral neuritis. The third nerve is affected in precisely the same way, although not so frequently, as the muscular branches of the musculo-spiral and posterior interosseous.

Many theories have been advanced respecting the essential structural changes in the various manifestations of chronic lead-poisoning. Whatever secondary alterations may occur it is probable that the process begins (Oeller, Kussmaul, Meyer) in the terminal vessels as a fatty metamorphosis or arterio-sclerosis (obliterating peri- or endarteritis). Later on, the nervous, muscular and other tissues supplied by these nutrient vessels may be converted into fat, fibrous tissue or the hyaline substance. As before mentioned, these changes, when they occur in the retina, may, during life, be studied ophthalmoscopically.

The following five cases reported by Landesberg will serve to show the results of treatment in cases of lead amblyopia.

Case 1. Patient 40 years of age; worked fifteen years in plumber's shop. Had several times suffered from general attacks of lead-poisoning. Atrophy of both papillæ. V., R. = 10/200; V., L. = fingers at four feet. The treatment consisted of warm baths and hypodermic injections of strychnia, after which V., R. = 10/100; L. unchanged.

Case 2. Lead worker 21 years of age, who handled chiefly lead oxide, besides general symptoms had paralysis of the rectus externus on right side. Complete recovery.

Case 3. Lead worker, 34 years of age, had several attacks of general lead symptoms. R. E., complete paralysis of all branches of the oculo-motorius. Pupil slightly contracted and the accommodation normal. KI and diaphoretic treatment did no good, but strychnia subcutaneously brought about a complete cure.

Case 4. Lead worker, 39 years of age, had central atrophic excavation of both papillæ with great narrowing of the arteries; also commencing ataxia and interference with audition. V., R. = 20/200; V., L. = 10/200. Treatment did no good.

Case 5. Painter, 23 years of age, who had shortly before suffered from lead intoxication. Neuritis optica, both sides. V., R. = 20/70; V., L. = 20/40. KI with pilocarpin *sub cutem* brought about complete recovery and good vision.

Breuer advises local blood-letting, the artificial leech to the temples once a week, with subcutaneous injections of morphia into the temporal region.

A few additional cases of lead amblyopia are here given further to illustrate the varied phases of this disease.

A woman, aged 30, took for an indigestion, instead of bicarbonate of soda, a teaspoonful of red-lead oxid with some water. After about two weeks Wirsing (*Deutsche med. Woch.*, p. 1845, 1907) noted symptoms of lead intoxication: colic, headache, tinnitus, palpitations of the heart, dyspnea, profuse perspiration, vomiting, vertigo. About two months after the accident her memory failed and visual disturbances set in with diplopia and micropsia. Then she became drowsy and could not recognize anybody, so that she had to be taken to the hospital.

Examination of the eyes by Helbron, 6 weeks after admission to the hospital, revealed: V. R. = 5/v, V. L. = 5/vi. Left mydriasis, reaction of both pupils sluggish, paresis of left superior oblique, contraction of left visual field from 15° to 20°, color perception normal, optic neuritis, with commencing atrophy in left eye. Under pilocarpin instillations, warm baths and iodid of potassium, a rapid improvement took place of the general and eye symptoms, and the paresis of the left trochlearis was perfectly cured.

Wirsung emphasizes the great discrepancy among authors as to the frequency of lead-poisoning. Lewin mentions 187 cases and says that amblyopia saturnina is a rather common occurrence among the working men in the lead mines of the Oberharz.

Amblyopia saturnina has been observed without any objective symptoms and is thus analogous to the anesthesia saturnina of the peripheral nerves; or it may be due to uremia, anemia of the retina from arterial spasms, or a symptom of incipient or complete papillitis, neuroretinitis, commencing atrophy, occasionally simulating cerebral tumor. Hemianopsia, hemiachromatopsia, affections of the sympathetic nerve, with oculo-pupillary symptoms; narrowing of the palpebral fissure, spastic miosis of the ocular muscles in various combinations, as pupillary affections from paresis of the third nerve, have been described.

Gibson (*Br. Med. Journ.*, Nov. 14, 1908; review in *Oph. Review*, p. 17, Jan., 1908) reported on 62 cases of plumbism of which 13 were cases of "ocular neuritis." Under this term the author included affections of the optic and of the external ocular nerves. At the time of writing, he says, when a child under eight years of age is brought to the consulting room suffering from a recently-acquired internal squint, and this squint is found to be due to paralysis or paresis of one or both external recti, he expects to find double optic neuritis, and if this be found the provisional diagnosis is lead neuritis.

The disease is characterized by sudden onset of paralysis or paresis of one or both external recti. There is double optic neuritis or choked disc. There is no rise of temperature or albuminuria. There is the blue line on the gums due to deposit of sulphide of lead, and small quantities of lead may usually be found in the urine. At the time of onset there may or may not be preliminary colic, vomiting, constipation, severe headache, rigidity of neck, or retraction of head with acute pain at back of head. Isolated cases are likely to be mistaken for basal meningitis or cerebral tumor.

The children thus affected are almost always between two and eight years of age. In Queensland all cottages and wooden dwellings are raised a few feet from the ground and are surrounded by verandahs in which the younger children constantly play. The verandah railings are painted with a white paint containing the very soluble carbonate of lead. While the paint is still wet, and still more when, by lapse of time, it has become powdery and easily detachable, the children get it on their hands. Observation has shown that those who suffer are especially those who bite their nails or suck their fingers.

Since the source of the poison has been discovered parents have been warned to substitute a harmless white, such as zinc, for white lead on

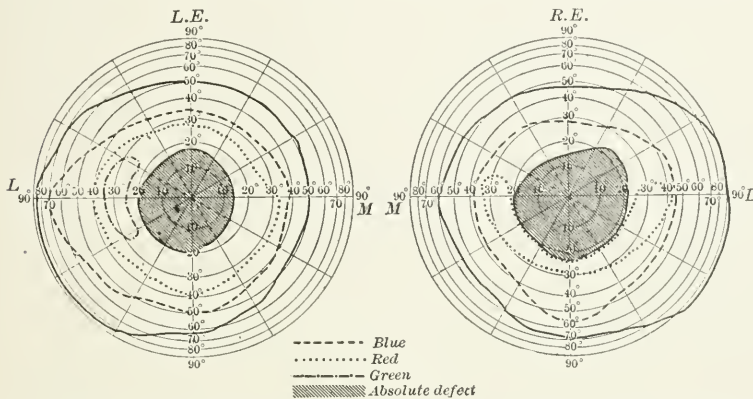
such parts of their houses and railings as are within the reach of children. Fresh attacks, formerly common, especially as regards foot- and wrist-drop cases, have thus been avoided. In some cases in which the warning has been disregarded the children have been brought back with relapses. The ocular attacks have seldom been met with in children suffering from foot- or wrist-drop, but before the source of the poison was discovered it occasionally happened that a child who had previously suffered from ordinary lead palsy was admitted later with ocular neuritis, or *vice versa*. In some children brought with defective sight slight or pronounced post-neuritic atrophy has been found, and although there was no history of acute attack or of squint, it has been possible to diagnose plumbism and to improve the vision by appropriate treatment. In many older children, some of them occupants of the Blind Asylum, a post-neuritic atrophy can be traced back to the same cause.

The treatment has consisted in removal of the children from their homes, confinement to bed, administration of dilute sulphuric acid and saline laxatives, daily hypodermic injections of pilocarpin continued for six weeks, and, after the first few days, iodide of potassium, the quantity for a child of eight years being 5 grs. thrice daily. In presence of cerebral symptoms lumbar puncture, repeated every few days if the puncture gives indication of increased tension, has lately been found helpful. Anterior arm splints have helped to prevent the nail-biting habit.

The ocular cases do not die, and there is an absence, therefore, of post-mortem evidence as to the exact nature of the neuritis. Extreme swelling of the discs, viz., 5 to 6 dioptries, is common. Hemorrhages are uncommon and never large. The optic neuritis has not been seen without the paralysis of one or more of the external muscles. Fortunately the presence of the squint draws attention to the child early in the attack. Vision may still be excellent when the swelling of the optic discs has reached several dioptries. In cases removed from their surroundings and treated before swelling of the discs has existed long, and while sight still remains good the outlook is hopeful, although not certain. The defect of vision, both in acute and in chronic cases, is a diminished acuity with concentric narrowing of the fields. As a rule the color-sense is relatively not more reduced than the light-sense. A child who counts fingers at 5 or 6 yards will show no color scotoma either for white or for color.

L. D. Brose (*Archives Ophthalm.*, 44, Jan., 1915) has recorded a case of paresis of the ciliary muscle, occurring as a consequence of lead-poisoning.

I. L. Harris (*Journ. Am. Med. Assocn.*, Sept. 14, 1918) has made a study of lead-poisoning among painters. This study has a peculiar import from the fact that frequently those already affected do not suspect the existence of lead poisoning; still others do not seek medical aid until they have had a breakdown; and not infrequently the origin of the complaints of the afflicted fails to be identified as due to industrial conditions. In New York, Harris found a rate of prevalence of 40 per cent. of active cases of lead-poisoning in examinations of more than 400 painters at the Occupational Clinic of the Health Bureau's Division of Industrial Hygiene. All of these showed definite



Field of Vision in Lead Amblyopia with Temporal Half of the Papilla Discolored; as in Tobacco-alcohol Blindness. (de Schweinitz, after Uhthoff.)

clinical signs of plumbism, and half of the affected group were found to have lead in the urine—a significant sign—in addition to the more purely clinical evidence. The heaviest incidence of saturnism was among those who had been painters ten years or more. The action of lead is slow in asserting itself, but according to Harris less than half who have passed the age of 40 as painters escape the disease.

Of the various safeguards proposed to reduce the danger of the painter's work none rank above personal hygiene. Workers ought to be made more familiar with the hazards that lead, turpentine and benzine entail. They should be educated to make more than a perfunctory exercise of washing the face, hands, mouth and beard, particularly before eating. Facilities for cleanliness should be made available. Meanwhile, Harris believes, compensation for occupational diseases, and for occupational lead-poisoning in particular, will do more to safeguard the health and lives of workers than any other single legal or hygienic measure. Nevertheless, we can not absolve the

individual from his share of personal responsibility acquired by an intelligent recognition of the character of his occupation.

In this connection, the investigations of S. McMurray (*Annals of Ophthalmology*, January, 1916) are worthy of study. He examined the eyes of twenty-two persons plainly exhibiting symptoms of plumbism and was able to follow up sixteen of these cases. He found among other abnormalities (but no marked fundus changes) more or less contraction of the visual fields in every case. Three persons had a central scotoma for red and blue; seven showed a relative scotoma for blue; ten had contracted field for blue; three had paresis of the external recti, and nine limitations of the accommodative power. The writer found that these symptoms persisted in spite of all treatment so long as the painter continued his work, but when he changed to a non-lead occupation the plumbism gradually disappeared.

Leukomains. Leucomains. Consult p. 7442, Vol. X of this *Encyclopedia*.

Lyc. See p. 557, Vol. X of this *Encyclopedia*.

Male fern. See *Filix mas*, herein.

Marsh gas, or choke "damp," was believed by Van Reuss (*Archiv f. Augenheilk.*, Vol. 33, pt. 3, p. 252) to be the principal cause of miner's nystagmus.

Meat, Decomposed. See *Botulism* in this section.

Mercurial compounds. Casey Wood (*loco cit.*, p. 15) has pointed out that workers in mercury, especially calomel makers and those using amalgams of tin and mercury for "silvering" mirrors, are liable to have ocular troubles which probably result from the absorption of the metal or its salts through the skin and lungs. The extensive employment in medicine of mercurial preparations would furnish a long list of amblyopic patients if these agents had a special predilection for the ocular structures. That mercurial amblyopia is very rare proves the contrary. In former years when mercury was usually pushed so as to produce its toxic effects, the optic nerve did certainly suffer to a much greater extent than it does in more modern times. Himly, (*Krank. u. Misbild. des Auges*, p. 422, Vol. II, 1843) for instance, gives a place in his work to *amaurosis mercurialis*. Leber does not think that the case for mercury is well grounded. Galezowski reports an example of optic atrophy and Square (*Lond. Oph. Hosp. Rep.*, VI, p. 54) one of optic neuritis, ascribed to the toxic action of mercurial salts.

Mercuric methyde. MacAdam (*Edin. Med. Journ.*, p. 718, II, 1866) claimed that this compound had produced a decided amaurosis.

Mercury bichloride. Sublimate. See p. 7651, Vol. X of this *Encyclopedia*.

Mescal amblyopia. See *Anhalonium lewinii*, in this section.

Methyl alcohol. See *Alcohol, Methyl*, in this section.

Methylated spirits. See, also, under *Alcohol, Denatured*. It is rather surprising when one knows that in not a few instances a toxic amblyopia has been produced by very small quantities of methyl alcohol in susceptible individuals, that methylated spirits and its American form—denatured alcohol—have been responsible for so few cases of damaged eyesight. However, there are at least several well authenticated cases where the vision has been affected by indulgence in this strong smelling liquid. Although the admixture of ordinary ethylic with methyl alcohol, to produce the “methylated spirits” of the arts, was expected to prevent its use as a beverage, it is well known that the thirst for alcohol has often overcome the repugnance which even the well-seasoned nose and stomach of the drunkard must have for this nauseous mixture. The poisonous effects are, in the published cases, due to the methyl alcohol in both the American and the British mixture.

Methylen bichlorid. This anesthetic fluid, allied to chloroform and said to be a mixture of it and methylic alcohol, produces eye symptoms the direct opposite of the former (q. v.) viz.: miosis in the first stage of the narcosis, but dilated pupils in the later stages.

Morphia and its salts. See *Opium* in this section.

Muscarin. See *Botulism*, in this section.

Mustard gas. Dichlorethylsulphide. This toxic agent is, perhaps, the best known of the poison gases used in the World War of 1914-1918.

The Editor is indebted to the *War Manual on Head Surgery*, published by the Surgeon-General, U. S. Army, for the following review of the extremely important subject—*ocular lesions in “mustard” gas poisoning*.

Warthin, Weller and Hermann (*Jour. Lab. and Clin. Med.*, Vol. IV, No. 1, October, 785, 1918), in a comprehensive study of the ocular lesions produced by “mustard gas” (dichlorethylsulphide), review the only clinical descriptions available in the general literature (Giraud: *Jour. de Méd. et de Chir. Prat.*, 1917, lxxxviii, 890; Juelières: *Jour. de Méd. de Bordeaux*, November, 1917, lxxxviii, February, 1918, lxxxix; Juelières and Valois: *Archives d’Ophtal.*, 1916-17, xxxv, 403; Pissarello: *Giornale di Med. Mil.*, 1918, lxvii, 128; Canelli: *Revista Ospedaliera*, 1918, viii, 2). They found a notable absence of pathologic studies in the published reports. Indeed, despite the fact that Victor Meyer, the discoverer of “mustard gas” (*Ber. deut. chem. Gesell.*,

1886, v. 19; 3259, v. 20, 1729) noted the conjunctival lesions in man and in experimental animals, the literature contains no reports of further investigations in this direction. Warthin and his associates, therefore, open a new field in ophthalmic pathology. Free excerpts from their report are given below.

Experimental "mustard gas" lesions of the eye. Application of the gas to the conjunctiva was made (1) directly, (the liquid applied directly to the center of the cornea by means of a fine pipette); (2) indirectly (the animals were exposed to the vapor in varying concentrations and for varying times in a respiration chamber especially devised for the purpose). Both pure and crude forms of mustard gas were employed. Rabbits and dogs were used for the experiments.

The gross pathologic changes are summarized by the writers as follows:

1. The standard drop of 0.0004 c.c. when applied directly to the cornea of animals was found to produce results practically identical with those produced by an exposure of 15 minutes to a vapor concentration of 1:20,000.

2. Dichlorethylsulphide produces after one or two minutes exposure to drop or highly concentrated vapor a definite irritation of the conjunctiva with increase of lachrymation. Usually within thirty minutes there is a well-marked hyperemia, followed in an hour by the development of edema, which progresses rapidly up to the twelfth hour, when there is usually a well-marked chemosis. Minute subconjunctival hemorrhage may develop as early as the tenth hour.

3. In animals the edema develops first and most markedly in the palpebral conjunctiva, following the direct application, while in the exposure to mustard gas vapor it frequently develops first in the bulbar conjunctiva, this being practically the only difference observed in the effects of the two methods. By the end of the third day the edema begins to subside slightly, but persists to some degree for several weeks. In man the edema is less marked, more irregular, while the hyperemia is more marked, the minute vesicles may be found on the conjunctival surface.

4. The necrosis of the cornea is shown by a definite cloudiness developing in five to six hours, which usually at eight hours has reached such a degree that the cornea takes on a porcelain-like appearance in the form of a very characteristic bluish-white opalescence. In the mildest cases the lesion does not progress beyond a slight cloudiness. Intravital staining with an alkaline aqueous solution of fluorescein shows very early the development of the corneal necrosis, even before ulceration has occurred. A striking phenomenon is the frequent occur-

rence of a more opaque band or line running horizontally across the cornea just below its transverse diameter.

5. A sero-purulent exudate is well developed by the fifth to the sixth hour and increases until the eyelids are usually sealed by the accumulated exudate by the tenth hour. This adhesion of the lids remains unless forcibly separated. If the eyes are frequently examined with consequent separation of the lids and removal of the accumulated exudate, the stage of purulent exudation is perceptibly shortened.

6. With the subsidence of the edema a characteristic kinking or "ruffling" of the upper lid, a combined entropion and ectropion, appears, usually by the fifth or sixth day. At the same time the lower lid begins to exhibit a smooth ectropion.

7. Depilation of the lid hairs and of the face hairs, eventually about the entire orbit, takes place.

8. During the second week changes in the corneal curvature are constantly noted, some of these so marked as to appear staphyloma-like.

9. Hypopyon sometimes occurs. Clouding of the contents of the anterior chamber occurs quite regularly in the later stages.

10. From the third week on the lesions slowly progress in a manner characteristic of the mustard gas lesion of the skin towards resolution and repair. The "ruffling" of the upper lid increases up to the eighth

Thirteen cases of *mustard gas amblyopia* are reported by Warthin and his associates, from which the following summary is drawn:

Exposure to varying concentrations of vapor of dichlorethylsulphide for varying periods produces a conjunctivitis showing all stages and degrees of intensity from a simple acute type to a severe chronic proliferative conjunctivitis. The symptomatology and clinical picture may vary greatly. The lesions are most marked in that portion of the bulbar conjunctiva exposed in the palpebral fissure. The milder cases recover after several days or weeks, but in the more severe cases develop chronic hyperemia of the conjunctiva, new formation of vessels and scar tissue in the most severe, with more or less permanent disturbances of vision. One of the cases observed developed an almost complete amblyopia in one eye, so that only the perception of light and shadows was possible. In another case marked bilateral gradual reduction of vision was noted. A xanthoma-like pigmentation was also noted in the chronic cases, the pigmentation developing near the outer or inner sclero-corneal junction, or over the corneal limbus.

There is no evidence of any metastatic involvement of the eye. In cases showing severe burns of other parts of the body, arm, leg, etc.,

no conjunctivitis, even of the simplest type, developed. Such exceptions are explained entirely by the fact that the vapor did not reach the eyes externally. In other cases with severe burns over the entire body with the exception of the face, which was protected by the gas mask, no eye or conjunctival symptoms were noted.

Naphthalin. See p. 3251, Vol. III; as well as p. 8287, Vol. XI of this *Encyclopedia*.

Although experiments on rabbits show that this drug produces cataract in them, yet it by no means follows that the same result obtains in the very differently constructed human eye. Casey Wood reports that during his service of a year at the Alexian Hospital he examined carefully a large number of typhoid patients (treated with maximum daily doses of naphthalin for several weeks) but in none of them did the lens, with a fully dilated pupil, show the least trace of cataract.

Naphthol. Consult p. 8287, Vol. XI of this *Encyclopedia*.

Neoarsphenamin. See *Salvarsan* herein.

Necsalvarsan. See **Salvarsan**; also the same sub-heading in this section.

Neurin. Consult p. 8324, Vol. XI of this *Encyclopedia*.

Nicotiana tabacum. *Nicotin.* See p. 8370, Vol. XI. See, also, **Tobacco**; as well as the same caption in this section.

Nitrobenzol. *Dinitrobenzol.* See p. 8374, Vol. XI; also, p. 9048, Vol. XII, of this *Encyclopedia*. See, also, *Dinitrobenzol* in this section.

Nitrogen monoxid. Consult p. 8374, Vol. XI of this *Encyclopedia*.

Nitreglycerin. According to Nieden (quoted by Berger) ophthalmoplegia may be a late symptom in this intoxication.

Nitrenaphthalin. Consult p. 8375, Vol. XI of this *Encyclopedia*.

Nitrostyrol. See p. 8375, Vol. XI of this *Encyclopedia*.

Nitrous oxide. Apart from a note by Aldridge, of dilation of the retinal vessels and hyperemia of the papilla, few authorities have seen any disturbance of vision from this widely used anesthetic. Among these is Bordier (*Journ. de Thérapie*, p. 885, 1876) who reported a temporary though very marked miosis an hour after the anesthetic extraction of a tooth. See **Anesthesia**, in this *Encyclopedia*.

Opium and its derivatives. See p. 2200, Vol. III; also, p. 9052, XII, of this *Encyclopedia*.

The opium habit (contrary to what one would expect from the dreadful inroads it makes upon the nervous energy) is not to any great degree a cause of true amblyopia. Everybody is familiar with the dull cornea, the leaden iris, the injected conjunctiva and the contracted pupil of the opium slave, but visual disturbances apart from these,

due to opiates, are quite uncommon when one remembers how widespread the use of opium is. Galezowski quotes Ali as saying that he had met in Teheran among the opium smokers there, several cases which resembled tobacco amblyopias, but as he does not exclude the possibility of their being also haschisch users the etiology of the affection is somewhat obscure. And Galezowski's own case was successfully treated by stopping immoderate doses of opium and tobacco. The following is the history of Wagner's well-known case:

Man, 32 years old, suffered from periodical vomiting which he treated with hypodermic injections of morphin. On a journey the old symptoms set in and in five days he used 1.92 grms. (30 grs.) of morph. acet., although from insecure hand may not have injected it all. Patient was found somnolent and with very slow, small pulse. Both pupils small and sluggish. The retinal arteries were extremely narrow, the papilla hazy, and the veins normal. The light of a half turned down lamp was not perceived. Same conditions for two days. Patient was then removed and no further history could be obtained.

de Schweinitz (*loci cit.*, p. 169) quotes Reymond (*Torpor of the Retina*) who reported a case that presented the aspect of atrophy of the optic papilla, restriction of the visual field, and a central scotoma attributed to chronic poisoning by opium and chloroform.

Hammerle (*Deutsch. med. Wochenschr.*, 1888, xiv., p. 838) has described a case, in some respects analogous to Wagner's, of temporary loss of sight from the internal use of tincture of opium. The patient, to relieve colic, took within twelve hours a sufficient quantity of the tincture to equal 1.5 grammes of opium. The pupils became the size of pins' points, and there was complete loss of sight, which returned in four days after vigorous purging. The reporter attributes the blindness to cramp of the retinal vessels.

Knies quotes a case observed by Schiess-Gemuseus, namely, a sixty-five-year-old man, who, after a sleeping powder, was somnolent for thirty hours, and then had considerable disturbance of vision and hearing. After three weeks there was right-sided half-blindness, and on the left side concentric contraction of the visual field. The papilla was analogous in appearance to that seen in intoxication-amblyopia, namely, red on the inner side and white on the outer half.

de Schweinitz examined a number of opium-eaters, one being a woman in middle life who daily consumed an enormous quantity of the drug, and had not found the slightest indication of toxic amblyopia.

Experimenting on rabbits with morphine, Laborde noticed congestion of the eye-ground, followed, after some days, by a persistent pallor of the nerve-head. Loring could find no change in the fundus

during the physiological action of opium, an observation which corresponds with de Schweinitz's experience.

Opium and morphine poisoning, as Leber points out, has not been proven to produce toxic amblyopia in the true sense of the word; but the cases of Reymond and of Schiess-Gemuseus indicate that careful ophthalmoscopic examination, as well as color tests, should be made in all cases of opium habit. It is possible we may find that under certain circumstances this drug should be relegated to those substances which have the power of producing some change in the fibres of the optic nerve which are specially gathered in the papillo-macular bundle.

Optochin. Ethylhydrocuprein. Consult p. 9094, Vol. XII of this *Encyclopdia*.

This complex synthetic derivative of copper and quinin, rather widely used as a specific in the treatment of pneumococic conjunctivitis, was in Germany for a time also employed internally in the treatment of pneumonia. Thus used, however, the drug proved to be dangerous, developing in a number of cases an amblyopia closely resembling that produced by the ingestion of quinin and its salts. For example, this complication occurred in 14.3 per cent. of the cases observed by Fränkel in which the drug had been employed for pneumonia. In these cases from one to 2.5 grams were administered internally daily.

A case of this rare form of drug amblyopia is reported by W. Feilchenfeld (*Deutsch. med. Wochenschr.*, Mar. 16, 1916). Five grams of optochin were given to a 20-year-old pneumonia patient in hourly doses of 0.2 grams each. Within two days poor hearing developed, and on the next day there was a decrease in vision. Complete blindness set in on the subsequent day. The pupils were found to be dilated *ad maximum*. The fundi were normal except for a narrowing of the vessels on the disc. Sodium iodide was given in large doses, as well as tincture of strophanthus. Under this treatment there was a gradual recovery, first of the hearing and eventually of the sight. Two months later the corrected vision was 6/6, although there were a concentric contraction of the visual fields and a large paracentral scotoma. Hemeralopia and scintillating scotoma gave the patient a great deal of subjective annoyance. The ophthalmoscope showed bilateral optic atrophy.

L. Schreiber (*Graefe's Archiv für Ophthalm.*, Vol. 91, p. 305, 1917) has also published a case. A doctor, aged fifty-four years, who was ill with croupous pneumonia, received in the course of four days four doses of 0.3 gm. each of quinin hydrochloride, fourteen doses of 0.25 gm. each of optochin hydrochloride, and from the fourth day one

tablet of digipuratum three times a day. In the night of the fifth to the sixth day of the illness bilateral amaurosis developed, which gradually disappeared after eight to ten hours. The visual acuity soon became normal again; but after a further two months the patient complained of cloudy vision and dazzling, and after a further seven months night-blindness was demonstrated.

John Weeks (*Oph. Year-Book*, p. 224, 1916) has reported an instance of the oculotoxic effects of this drug on a girl, aged 16 years, who was given 2 grams of ethylhydrocuprein in 0.2 gram doses. Four hours after the last dose she could not see. About eighteen weeks later vision 20/30ths. Light perception 80, color-vision indefinite. The disks considerably paler than normal.

Geo. H. Oliver (*Br. Med. Journ.*, Apr. 22, 1916) has fully described a serious example of the toxic effects of ethylhydrocuprein on the eye. In the early part of 1915 he was called to see a man, aged 40, who a month before was extremely ill with pneumonia, and who was given ethylhydrocuprein in 5-grain doses every three hours. The patient took in all 120 grains.

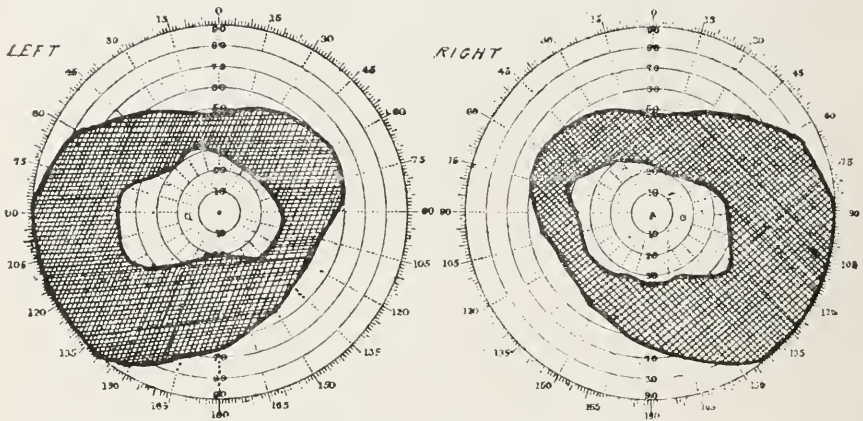
The day previous to the discontinuance of the drug the patient complained of roaring in the head, partial deafness, and a feeling as though a dark blind had been drawn over his eyes. He was so ill and difficult to understand that these symptoms were considered to be due to meningeal complications. The drug was stopped next day, when it was found that he was quite blind and could not distinguish light from dark.

Oliver found (Feb., 1915) bare perception of light; the right pupil reacted very slightly to light, the left not at all. Pupils two-thirds dilated. Ophthalmoscopic examination showed that the vessels were reduced to fine threads, the arteries being made out with difficulty in the left eye; both discs were quite white. On March 11th, 1915, there was considerable improvement in vision; could find his way about inside and outside the house, and could distinguish such articles as a knife, fork, or spoon at three metres.

On April 3rd, 1915, there was much improvement; V. = R. 6/18, L. 6/18; reads J. 4 slowly c L. E. and c R. J. 14; both fields very much contracted; pupils reacted to accommodation and slightly to light. Color-vision obliterated. Right disc not quite so white, but vessels still attenuated, more so in left eye.

On June 5th, 1915, V. = R. 6/9, L. 6/6. Ophthalmoscopic examination: Right eye, faint blush on temporal side of disc. Left disc quite white and vessels reduced to fine threads. Pupils both oscillate in a remarkable manner, synchronously, in day and gas light.

August 25th, 1915. V. = R. 6/18, L. 6/18; near vision = J. 4 c R. and L. "Complains of severe pains in the back, which have troubled him more or less since convalescence set in. Attacks last a few days, during which visual acuity is considerably lowered and fields much more contracted, with immediate restitution to former level when pain ceases. Small colored objects 2 to 3 mm. in diameter not recognized, but most larger objects, such as postage stamps, red and green colors, are easily named. It is impossible to map out the color fields (Bardsey's scotometer); the patient is so uncertain of the boundary zone. Ophthalmoscopic examination: Disks as before; vessels, arteries, and veins have a well marked double outline, which is carried a consider-



Optic Fields of Vision in a Case of Optochin Poisoning. (Oliver.)

able distance beyond the disc, and in one or two instances is more distinct than the blood column.

"The most striking circumstance is the great improvement made up to June 5th, 1915, which one would have little expected, seeing that the vessels were so narrow and the discs so white, indicative of the destruction, from reduced blood supply, of a large number of ganglion cells in the retina, and the visual fields so much reduced, as shown in the accompanying charts.

"February 5th, 1916, V. = R. 6/60, L. 6/60. Vision began to go down in November, 1915, and steadily declined until Christmas, when he could not see his food on the plate before him. In the second week of January, 1916, he began to improve, and has continued to do so up to date. Ophthalmoscope: Both discs now quite white with no trace

of color; details not discernible. Vessels seem to have increased in size a little, and a few very fine branches may be seen on the discs. Vessels in left eye are smaller than in right eye, and both arteries and veins have a double outline which extends far away from the disc.

“Apart from these changes, the fundus is quite normal in appearance. Pupils are dilated and contract very slightly to light and still oscillate.”

Orsudan. See p. 609, Vol. I; p. 1130, Vol. II, and p. 9193, Vol. XII of this *Encyclopedia*.

Osmic acid. There are few examples of blindness from poisoning by this chemical.

H. P. Noyes (*Trans. Am. Oph. Soc.*, p. 34, 1866) has furnished almost the only one on record, as follows: Dr. P., an assistant in a chemical laboratory, was heating osmium and iridium in a crucible. Although aware of the poisonous properties of the fumes he took out a bit of the former metal with his forceps and put it near the left eye for inspection. Immediately he was struck with a sharp pain and ten minutes afterwards saw Dr. Noyes. There was great blepharospasm, photophobia and bulbar pain. Conjunctiva and sclera injected; lachrymation profuse. Pupil of normal size and activity. Vision reduced to one third and patient reads only Jäger 3. All objects looked dim. No paresis of accommodation. Fundus normal (except perhaps a pink papilla) and media clear. The symptoms remained for one day, after which the eye resumed its normal function. Dr. P., as well as Dr. Noyes, thinks that the toxic influence was mainly exerted upon the retina.

Oralic acid. Koch (*Inaug. Diss.* Dorpat, 1879) found mydriasis at first, followed by miosis, in experimenting on rabbits, but what the effect is on human eyes nobody knows. de Schweinitz remarks that this agent, being an active irritant poison having the property of altering the composition of the blood, has sometimes been mentioned in the list of those substances which produce visual disturbances, but probably only in the sense that the failure of sight is secondary to exhaustion.

It should be remembered, however, as Kobert and Kürsner have shown, that glycosuria may occur in oxalic acid poisoning; possibly this complication may explain some of the visual disturbances which have been recorded.

Pelletierine. See *Pomegranate* herein; also p. 9402, Vol. XII of this *Encyclopedia*.

Phenol. Consult p. 61, Vol. I, and p. 9629, Vol. XI of this *Encyclopedia*.

Phenozone. See *Acetanilid* herein.

Phosphorus. The oculotoxic effects of this poison are mentioned on p. 9694, Vol. XIII of this *Encyclopedia*.

In addition it may be said that there is a close resemblance between the morbid changes in the tissues of persons affected by this intoxicant and those of persons poisoned by one or both of the oxides of carbon. The ocular symptoms and tissue alterations are for that reason much the same in both instances. In chronic intoxication, affecting workers in match factories, for example, hemorrhages and patches of degeneration in the retina are sometimes seen. The latter are composed of the altered (fatty) external granular layer, mixed with crystals of tyrosin. The process begins with a fatty degeneration of the retinal capillaries in the same way that phosphorus-poisoning affects the smaller vessels elsewhere; an ophthalmoscopic picture that resembles the retinitis of albuminuria. See *Coal gas*, in this section.

Physostigmin. See *Eserin* in this section.

Picric acid. There are very few instances of amblyopia due to this cause. Hilbert's experiments upon himself furnished symptoms similar to those resulting from *santonin* poisoning. Two hours after taking 0.3 grm. of *picric acid* he had slight yellow vision which lasted two hours, after which blue and violet were not distinguished. This was not, he thinks, due to a yellow coloration of the optic media, but to the irritant effects of the poison on the cerebral centers.

Pilocarpin and jaborandi. As is well understood, *pilocarpin* and *jaborandi* used as miotics may have a temporary effect upon vision but a true amblyopia from these agents is extremely rare.

Locally always powerful miotics, the chief eye symptom in general poisoning is, as with *physostigmine*, mostly *mydriasis*. Fuhrmann relates a case of *luetie papillo-retinitis* in which a hypodermic injection of 0.01 grm. of *pilocarpin* was given. Alarming symptoms set in accompanied by an amblyopia lasting two hours and a half. The patient could not recognize a person at 20 centimeters, although his left eye before the poisoning had normal vision. In an article on the subject *Landesberg* gives his experience of five cases treated with *pilocarpin* and *jaborandi* in which he observed sooner or later a quickly developed cataract.

Says *Berger*, "Although exceptional cases of transient amblyopia or of cloudy vision are commonly explained by the hypothesis of a disturbed intraocular circulation, it is more probable that *pilocarpin*, in poisonous doses, temporarily paralyzes the peripheral fibres of the optic nerve."

Pink-root. See *Spigelia*.

Piscidium. Jamaica dogwood. This narcotic agent produces mydriasis when full doses of the extract are given internally.

Pituri plant. See p. 4807, Vol. IX of this *Encyclopedia*.

Plumbism. This subject is fairly well discussed on p. 10290, Vol. XIII of this *Encyclopedia*, and under *Lead* in this section.

Podophyllin. Consult for the oculotoxic symptoms of this drug p. 10295, Vol. XIII of this *Encyclopedia*.

It may be mentioned here also that chemists' assistants, who grind certain irritant drugs, are prone to acquire conjunctival hyperemia, as well as acute inflammation and even corneal ulcers, unless the eyes are protected by a mask from the dust. Such is the case with podophyllum, as with many others that it is not within the province of this study to mention.

Poison ivy. See p. 10300, Vol. XII; also under *Rhus toxicodendron* in this *Encyclopedia*.

Pomegranate. See p. 10311, Vol. XIII of this *Encyclopedia*. In addition, it may here be said that Dujardin-Beaumetz claims that the alkaloids, *isopelletierine* and *pelletierine* in this plant act like curare and produce retinal congestion.

Jacobson records an instance of poisoning by the extract where the effects resembled those of the cycloplegic intoxicants—paresis of accommodation and dullness of distant vision from the development of latent hypermetropia.

Mayer describes a case in which after a dose of 17.5 grms. of extract, graniti, mixed with the same quantity of male fern extract (divided into seven hourly doses of 2.5 grms. each), vomiting, faintness and unconsciousness lasting thirty hours were observed. The patient became blind in the left eye and visual acuity was dull in the right. The blindness was, in the light of other cases, probably due to the poisonous action of the male fern.

Potassium bromide. This drug is very seldom a cause of visual disturbances, although epileptics and others take it in large quantities and for long periods.

Notwithstanding the assertion of Laborde (*Archives de Physiol.*, May, 1868) that conjunctival hyperemia is the only ocular symptom caused by this drug, several recorded cases prove the contrary.

Perhaps the best marked instance is that related by Rubel (*Centralbl. f. pkt. Augenheilk.*, Oct., 1884) whose patient took 10-15 grms. (150-235 grains) daily. He was an epileptic, twenty-three years old and a spirit-drinker. One day he noticed that he was blind. The ophthalmoscope showed pallor of both discs and contraction of the

retinal arteries. The bromide was stopped and in five weeks vision returned. Subsequent doses brought back the visual disturbance.

Gifford (*Am. Journ. Ophthalm.*, p. 2451, 1890) relates the following case: H. T., æt. 15, strong boy, had convulsions for five years. Took daily 40—70 grs. of KBr., for a long period and developed in L. E. a central keratitis not controlled by ordinary remedies. Healed with opacity on stopping KBr. Shortly after convulsions returned and the bromide was again given. The R. E. became again affected by a branching keratitis similar to that of the other eye and of the same obstinate character.

Potassium chlorate. See p. 2063, Vol. III of this *Encyclopedia*.

Ptomains. See p. 10469, Vol. XIV of this *Encyclopedia*; also under *Botulism*, in this section.

Quinin. The amblyopia and amaurosis from quinin intoxication is discussed at some length on p. 3249, Vol. V; and to a slight extent on p. 10820, Vol. XIV of this *Encyclopedia*.

Arthur Ballantyne (*Br. Journ. of Ophthalm.*, p. 153, Mar., 1917) has reported a case of quinin amaurosis and remarks that several explanations might be offered to account for the *better recovery of central than of peripheral vision*. In the first place, it might be supposed that the initial ischemia, assuming that to be the cause of the amaurosis, led to a more profound and permanent loss of function in the ganglion cells of the less vascular periphery of the retina. Here we are met with the difficulty which confronts all vascular explanations of the affection, namely, that there is no parallelism between the degree of vascular contraction and the amount of visual loss, for in the presence of a stationary, or even increasing, ischemia, the vision may be steadily improving. Nor does the analogy of embolism of the central artery assist us at all, since, in a few cases of the latter which regain some vision, it is sometimes peripheral, sometimes central, sometimes in sectors, apparently according to peculiarities of the vascular supply. Again, it has been suggested that quinin exercises a selective action on the ganglionic elements in the periphery of the retina, just as tobacco selects those of the macular region. On the other hand, if we are to accept the theory that quinin acts by a direct toxic effect on the retina, through the blood stream, we must assume that the rods and cones, deriving their nutrition from the rich vascular supply of the choroid, are at least equally exposed to the poison. The different distribution, and the structural and functional differences of the rods and cones, makes it at least possible that we have an explanation of the peripheral defect in a selective action of quinin on the rods. The

night-blindness, so often complained of in these cases, supports this view.

Ballantyne believes: 1. That in quinin poisoning complete loss of vision may be found in association with a normal condition of the fundus oculi, and that there may be a striking recovery of vision in spite of the presence of well-marked fundus changes.

2. That in all, or nearly all, cases of quinin amaurosis, ophthalmoscopic changes, such as congestion of optic nerve and retina, pallor of the disc, narrowness of the retinal vessels, and cloudy opacity of the retina, make their appearance sooner or later, but that there is no correspondence between the character or severity of these changes and the intensity of the visual defect.

3. That the visual defect cannot, therefore, be due to such changes, but rather to a condition of the retinal elements invisible with the ophthalmoscope.

4. That this change may be induced, or aggravated, in the first place, by ischemia due to contraction of the vessels of the optic nerve and retina, but that it is, in the main, the result of a direct toxic action of quinin upon the retina itself, and that the ultimate recovery of central vision, with loss of peripheral vision, and failure of vision in twilight, suggests a selective action of the poison upon the rods.

By far the most complete and up-to-date study of this subject is furnished by R. H. Elliot (*Am. Journ. of Ophthalm.*, Aug.-Oct., 1918) from which we have drawn freely; indeed, the text to the end of this heading (*Quinin*) is taken, practically *verbatim*, from his paper. We have also reprinted Col. Elliot's bibliography to which a few references have been added.

This author points out that reported cases of quinin blindness reveal the most startling *variations in the dose of the drug required to produce pathologic phenomena* in different patients. One will take with impunity a dose which seems simply enormous, whilst another will show failure of vision from a quantity of quinin, which to the ordinary person would be absolutely innocuous. There are, however, certain factors which must be taken into account in every case: These are: (1) The salt of quinin employed; (2) the vehicle in which the dose is given; (3) the method of its administration; (4) the total amount of the drug retained in the system; (5) the individual idiosyncrasy of the patient; (6) the age, sex and weight of the patient. After all is said, one feels obliged to fall back upon that convenient though by no means illuminating explanation—*idiosyncrasy*.

The salt used. The sulphat of quinin is probably still employed more commonly than any other preparation, though the hydrochlorid

is very popular. If one may judge from the recent discussion before the Society of Tropical Medicine (London, March 15th, 1918), these two salts stand far ahead of all others in the esteem of experts. The relative solubilities of the various quinin preparations are given here in a tabular form.

Salt of quinin—	————Solubility————	
	In water	In alcohol
Sulphat	1 in 800.	1 in 65.
Acid sulphat	1 in 10.	1 in 45.
Hydrochlorid	1 in 35.	1 in 3.
Acid hydrochlorid	1 in 1.	1 in 5.
Hydrobromid	1 in 55.	1 in 0.7
Salicylat	1 in 630.	1 in 24.

Nierenstein has analyzed the urine of a number of patients who had been taking quinin salts. He found that the percentage of quinin in the urine was practically constant, regardless of the salt used (sulphat, hydrochlorid or hydrobromid), or of the amounts that had been administered. From this he deduced that there was a limit to the amount of the drug that could be taken up by the blood, and that this limit was indicated by the quinin-content of the urine. He made the suggestion that if a more soluble salt than the sulphat or hydrochlorid were used, the quinin-content of the drug could be greatly raised, thus intensifying the action of the drug on the malarial parasite. The form in which quinin is excreted is in combination with urea. He thought, therefore, that a carbamid of quinin might be the very substance for which tropical physicians were looking. The writer drew attention to the fact that de Schweinitz, in his experiments on animals, had used a carbamid of quinin as well as other preparations, and had found that salt more toxic than any other. Whilst, therefore, it might prove powerfully therapeutic, there was the possibility that by so highly cinchonising the blood, it might act unfavorably on the retina and optic nerve, and determine amblyopia and amaurosis.

It has sometimes been said that quinin is more dangerous than any of the other alkaloids obtained from the cinchona bark. But it seems possible that the true interpretation of this statement lies in the fact that quinin is in much more common use than any of these other substances.

The vehicle in which the quinin is given. Some of the patients, who presented pathologic signs, took the quinin in the form of powder, others in pills, others in one form or another of solution; whilst yet others drank comparatively large quantities of alcohol immediately

before or afterwards. This must undoubtedly have tended to intensify the action of the drug, by bringing it rapidly into solution in the stomach. On the other hand, the ingestion of quinin in pill or tabloid form introduces a great element of uncertainty into our estimate of the quantity of the drug actually absorbed into the system. Every tropical practitioner knows that stale pills or tabloids of quinin become as hard, and almost as insoluble as stone, and are passed through the alimentary canal from end to end as inert, useless masses. Even when fresh pills have been swallowed, if the quantity is large, the bulk and cohesion of the mass make it easily vomited in the first instance; and disposed to set up irritation, and so be rapidly voided in diarrhea movements, in the second. We shall return to this under our fourth heading Elliot continues.

The method of administration of the drug. One of the most interesting points brought out at the recent meeting of the Society of Tropical Medicine was the apparently undivided opinion that the oral method of administration is far and away the most satisfactory. Not a good word was said for intravenous injection, despite the fact that on the face of it, this would appear to be the only method which attains to absolute certainty in the knowledge of the dose administered. The comments on subcutaneous and intramuscular injection were equally unfavorable. This is not surprising, inasmuch as it has long been known, that when quinin is given in this way, a large quantity of it may remain indefinitely unabsorbed. It has fallen to the lot of many surgeons in the Tropics, to cut down upon and evacuate large masses of the kind, on account of the great irritation the patients suffered from them. Finally, amongst the records of quinin amblyopia, one finds a certain number of cases in which the drug was given per rectum, either in the case of children, or of others in whom gastric irritability provoked an intolerance of further administration by the mouth. This is a point to which the most earnest attention of the reader is invited, for it would seem that the little known symptoms of cinchonism were in some of these cases mistaken for those of malaria, and that the drug was consequently pressed, at a time when it should have been totally withheld. It is not difficult to see how disastrous such a course of conduct may prove.

Before leaving this topic, it is of interest to note the various conditions which led to quinin being taken in what proved to be poisonous doses. In the forefront of these, of course, stands administration by medical men, or by the patients themselves, for one or another form of fever, the most common of which was malaria. Many other febrile conditions, however, figure on the list, inclusive of pneumonia, influ-

enza chills, and numerous ill-described pyrexial states. A mention must also be made of "neuralgias," sometimes considered to be of malarial origin, and of toothache. Next we find a large group of cases in which the drug was deliberately taken for some improper purpose, especially for suicide, or for the production of abortion or miscarriage. Lastly we have the quite considerable group of "accidents." It certainly seems strange that a man or woman should swallow a huge dose of quinin sulphat by mistake for some comparatively innocuous salt, such as cream of tartar, but it unquestionably has been done (Giacomini). In all these self-prescribed instances the drug has been taken by the mouth.

The total amount of the drug retained in the system. This point is obviously one of very great importance in our estimation of "the dangerous dose." In many of the records we learn that the patient "vomited quite half the dose given," or that he "passed a large quantity of quinin by the bowel." Again, in the subcutaneous and intramuscular injection, usually no allowance seems to have been made for the fact that much of the drug probably lay inert, where it was first thrown by the syringe. The uncertainties thus introduced into our estimations are too obvious to need emphasizing. When the dose is accurately stated in the first place, it is the outside dose, but, the exact deductions we must make therefrom, in order to arrive at the quantity of the drug that did the damage, are more than open to question. This must be frankly recognized throughout.

The individual idiosyncrasy of the patient. From the point of view of the dangers that attend the path of the prescribing physician, when dealing with malaria, this factor probably far outweighs any other. It constitutes the great risk, beside which all others fade into unimportance, and it consequently demands a separate section to itself. In this quinin only falls into line with all the other drugs, which are responsible for producing one or other form of toxic amblyopia.

The age and sex of the patient. This probably resolves itself very largely into the weight of the subject, since women are on the average lighter than men, and children than adults. On the other hand, there seems some reason to think that women and children are especially liable to quinin poisoning. Allowance must of course be made for the fact that quite a number of the recorded cases have been in women who desired to produce abortion, and who took large quantities of the drug for that purpose. Probably, too, in some of the attempted suicides the motto was "death or abortion." It is, however, of the utmost importance constantly to keep in mind the dose of quinin in grains, as compared with the total body-weight of the patient. de

Schweinitz showed this in his early experiments on animals, and it is so cardinal a rule that it might seem a work of supererogation to insist on it, were it not for the fact that this essential piece of information is very rarely given in the published records of cases of quinin amblyopia.

When Elliot first started collecting his material, he did so under the influence of many years of extensive experience with malaria and its treatment in southern India, where his opportunities of meeting with quinin amblyopia would have been exceptional, had such cases really been common. He believes that the dictum of Laveran "not more than 45 grs. of quinin to be given in 24 hours," holds widely there; and to this he attributes the remarkably small number of cases of quinin blindness which he met with in the Madras Presidency. He cannot with certainty remember more than 4 or possibly 5 such cases. Although there were others which, judging from the ophthalmoscopic appearances observed, might doubtfully have fallen into the same category, it was impossible to be sure of the origin of the trouble in the absence of reliable histories. The result of such an experience was that the writer's attention was at first directed only to the records of those cases in which the patient had taken 2 drachms or less of quinin in 24 hours. Even then, quite a number of cases were found. The state of affairs which exists; or, perhaps one should say, existed, in certain backward parts of America, where doctors were scarce and the patient helped himself liberally out of a stock quinin bottle, hardly seemed to interest the surgeon who lives in parts where civilization has had time to progress. The opinions expressed by malaria experts of the first rank at the recent meeting of the Society of Tropical Medicine in London, have, however, compelled a modification of the standard thus set up. If military medical officers are going day after day to give from 60 to 90 grains a day, and then to carry on with lesser doses for a considerable time, we must include the cases which have shown toxic amblyopia after the administration of an ounce or more of the drug. Otherwise we shall not have a complete mental picture of the risks incurred. Of one thing there can be little doubt, namely, that the cases of quinin poisoning reported are but a fraction of those which have actually occurred. The writer has no wish to be an alarmist, but he cannot but feel that the new movement is fraught with perils which it is the duty of the ophthalmologist to point out.

Doses of quinin which have proved toxic. We shall start with the cases in which the dose is described as huge, immense, heroic, very large and so on. These are the cases of Behse, Browne (male, aged 34),

Burns (a male aged 16), de Schweinitz (a male aged 40), Fox (a male aged 13), Harbridge (5 sailors, each of whom took a large dose of quinin), Hobby (a female, aged 21), Knapp (two male children, aged 3), Nettleship (a male, aged 29), O'Brien (a male, aged 33), and Williams (a male, aged 14). Everyone of these appears to have been permanently damaged in sight.

Next comes the group in which the dose was about an ounce and upward: Calhoun (a female, aged 10, took one and a half ounces in three days), Guersent (an adult female took 631 grains in a few days), Judko (1.694 grains of hydrochlorid of quinin in 7 days), Michel (a male, aged 38, took 670 grains in 6 days), Reina (a male, aged 30, took 462 grains at one dose), Roosa (500 grains of cinchona in tincture), Shahan (a female, aged 28, took one ounce of quinin in six hours, during labor), von Kubli (a female, aged 23, took 454 grains), Williams (a male, aged 42, took one ounce in a week). In each recorded case the damage to vision was permanent.

Next are doses from about 3 drachms to half an ounce: Giacomini (a male, aged 45, took 180 grains), Kalebiakin (154 grains of quinin), Kirkpatrick (a female, aged 30, took half an ounce of quinin), Manolescu (a female, aged 30, took 200 grains of quinin), Parker (a male, aged 43, took 240 grains of quinin), Roosa and Ely (a female, aged 30, took 280 grains of quinin in 6 days), Tyson (a male, aged 23, took 240 grains of quinin in 3 days), Underhill (a female, aged 20, took 200 grains of quinin in pills, but vomited and passed a quantity), Weeks (a female, aged 51, was given 150 grains of quinine per rectum by mistake), and Zani (an adult, took 300 grains of quinin). In all these cases the damage seems to have been permanent.

In the next group are doses of about 100 grains: Ayres (a female, aged 7, was given 104 grains in 3 days), Harbridge (an adult male took from 60 to 120 grains in whisky), Kalebiakin (dose 100 grains), Keiper (a male, aged 75, took 120 grains after a drinking bout), Myer (a female, aged 20, took 120 grains in lime juice and water), and Terrien and Aubineau (a dose of 115 grains).

The next group includes doses of from 40 to 80 grains of quinin: Beydler (a dose of 40 grains of quinin sulphat), Cargill (a female, aged 28, took 60 grains of quinin sulphat), Claiborne (a dose of 60 grains), Fortunati (a male, aged 59, took 46 grains of the hydrochlorid in two doses, and died of fever), Gruening (a female, aged 35, took 80 grains of quinin sulphato in 30 hours), Kalebiakin (dose 80 grains), Kaz (an adult female took 40 grains of the hydrochlorid), M'Gillivray (a male, aged 54, took a 40-grain dose, probably with alcohol), von Speyer (a female, aged 41, took about 60 grains of quinin,

of which she vomited half), Weeks (a female, aged 6, was given 80 grains in 3 days), and Welton (a male, aged 31, took 55 grains of quinin in a quart of whisky). Again, as far as can be judged from the records, permanent damage was left behind in each case of these last two groups.

The next group includes the really small doses whose action points to a strong personal idiosyncrasy on the patient's part, except in the case of the child: Burns (a female child, aged 3, sustained permanent visual damage from a dose of 30 grains of quinin sulphat, given by the rectum in the course of 15 hours), Calhoun (a male adult had temporary amblyopia whenever he took 10 grains of quinin), de Schweinitz (temporary amblyopia followed the administration of 15 grains of quinin in divided doses in 24 hours), Miller (a sailor, aged 55, took 5 grains daily for 3 or 4 weeks and had temporary amblyopia), Nettleship (a male, aged 26, took 22 grains of quinin in 3 days and was still amblyopic 3 weeks later), Schwabe (a female, aged 33, took 19.29 grains of quinin hydrochlorid for toothache, and her sight was permanently injured thereby), Wood (an adult female suffered from amblyopia after taking 12 grains of quinin). The writer has under his observation a man of 60 who suffers from amblyopia with contracted fields if he takes 2 grains of quinin.

The last group is full of interest. It contains the cases collected by Conner, all of which either proved fatal, or at least gave rise to very grave anxiety. In Conner's own case, extreme cardiac depression with collapse was met with in a male, aged 27, following the ingestion of 6 grains of quinin. Death seemed imminent, but the patient recovered. It was known that he had always had a strong susceptibility to quinin, an idiosyncrasy which he shared with a brother and a sister. The following cases are mentioned in Conner's communication: Wood's patient showed very alarming symptoms after taking 2 grains of the drug; so did a girl of 13, under the care of Micciche, who had taken 8 grains of quinin. Upshur's case gave great cause for anxiety after a dose of 30 grains, and on a later occasion after a dose of 8 grains Huseman published 4 fatal cases, following the ingestion of 3 drachms, 5 to 10 drachms, 45 grains (in a child of three and a half), and 16 to 20 grains (in a child of two). To this list we must add the cases of the three Chinese coolies, mentioned by Gimlette, each of whom received about 90 grains of sulphat of quinin, in a single dose, on an empty stomach. Two died and the third was very ill with deafness, diplopia and delirium, but recovered.

It must not be forgotten that Berandi noted headache, tinnitus and obscuration of vision as signs met with in his experiments on healthy

individuals, to whom he administered doses of from 15 to 20 grains of quinin.

Alcoholic and acid solvents of quinin. Attention has more than once been directed to the danger that may accrue from giving quinin either in, or in connection with, an alcoholic or acid solvent. The cases of Harbridge, Welton, M'Gillivray, Keiper and Myer are all to the point. Their interest lies in the great severity of the symptoms at the time of the first poisoning, and in the extent of the permanent damage done. When one considers that these were all adult males, and that the doses taken were none of them really large (respectively 60 to 120 grains, 55 grains, 40 grains, 120 grains and 120 grains), one cannot easily resist the conviction that great care should be taken to regulate the doses of this powerful drug, when giving it in combination with solvents. The plain indication would appear to be that we should not let the quantities administered get out of hand, until we have made sure that the patient has no idiosyncrasy for quinin. It may be said that the same remark could be made with equal justice about quinin being given in any other form. Whilst this is quite true, the danger seems to be accentuated in dealing with dissolved and concentrated quinin, and therefore extra caution is demanded under such circumstances.

There are points of interest in connection with the repetition even of small doses of quinin. Thus, Miller's patient, a ship's captain, aged 55, took only 5 grains a day with the exception of one occasion on which he doubled the dose. Yet, after 3 to 4 weeks of this treatment, he had developed typical signs and symptoms of quinin amblyopia. It is true that he was a heavy smoker, but the ophthalmoscopic appearances presented, the absence of central color disturbances, the restriction of his visual fields, and the recovery of central vision, when quinin was stopped, show clearly that it was a case of poisoning by this drug.

It is of course possible that tobacco contributed to the toxic effect, just as we may see optic atrophy progress in a glaucomatous eye after the complete relief of tension, owing to the existence of some other hitherto unrecognized cause of autointoxication. That the latter is the correct explanation in such cases would seem to be clear from the fact that the removal of the accessory cause of autointoxication will sometimes arrest the atrophic process started by the glaucoma. It is possible that the action of quinin may be accentuated in the same way by that of one of the other drugs, which produce toxic amblyopia.

An extraordinary and somewhat unexpected light would appear to be thrown on this subject by Schwabe's case, of a woman of 33, who had suffered from quinin amaurosis for 19 hours, and from amblyopia

for three years after a dose of 19.29 grains of muriat of quinin, administered for toothache. Whenever she took a cup of strong coffee or strong tea, the retinal vessels could be observed to become powerfully constricted, and the fields of vision narrowed down almost to the fixation point. The maximum effect was attained in one hour, and the trouble had passed away in two. There was no evidence of permanent loss of central visual acuity, of central color vision, or of the area of the fields of vision, despite the fact that the patient daily indulged in these beverages, thus frequently repeating in her daily life what one would have thought was a hazardous experiment.

Caffein or thein is known to be a cerebral stimulant, and as such has been advocated in the treatment of quinin amblyopia, in spite of the fact that more than one writer has suggested, possibly on not very good evidence, that it may itself be a cause of toxic amblyopia. Schwabe's careful observations are calculated to revive such suggestions, and to indicate a measure of care in our use of the drug in quinin amblyopia. It is possible that the cases in which it acts disadvantageously are instances of individual idiosyncrasy, but it would be unwise to forget the lesson they teach. The writer, however, knows of one case in which the administration of strong coffee definitely resulted in the amelioration of the signs and symptoms of quinin amblyopia in a patient who is so sensitive to the drug that he presents contracted fields and interference with vision after so small a dose as two grains of quinin sulphat.

de Schweinitz lays stress on the *liability to relapse* shown, after the exhibition of small doses of quinin, by patients who have already suffered from poisoning by large doses of the drug; and draws attention to the fact that Knapp and Nettleship had both made similar observations. He himself has noted an exactly similar sequence of events in animals. Manolescu, in his very careful treatise on quinin poisoning, has drawn special attention to this phenomenon, and has urged that in the case of all patients, who have been known to have had quinin amblyopia in the past, the greatest care should be exercised, not only with regard to the use of the cinchona alkaloids, but also to that of any of the other poisons, such as alcohol and nicotin, which are known to be liable to produce amblyopia in any form.

The literature available contains at least two highly illustrative cases, which demand a short notice. Weeks' patient, a girl of 6, was given 60 grains of quinin one day by the rectum; and 20 grains more in the next two days. She suffered from severe amaurosis, but eventually recovered her central vision, though the fields remained much contracted. Twenty months later she was given a single dose of 10 grains

of quinin in one day, with the result that the signs and symptoms of poisoning of the optic nerve and retina returned with great intensity. Although she again recovered to some extent, a good deal of the damage done on the second occasion was permanent. In Hobby's interesting case "very large doses of quinin had been required to produce cinchonism" in the first instance; but when, on a later occasion, 20 grains of the drug were administered, the patient had a very severe return of amblyopia; which affected both her eyes, whereas in the original attack, the right had nearly escaped.

Method of onset and course of attack. A very careful analysis has been made of the reported cases of quinin poisoning, with a view to ascertain the methods of appearance and of development of the signs and symptoms of this condition. This survey has revealed very great differences in different cases. This is only what might have been anticipated, in view of the facts that the size of the dose and the method of taking it varied very widely, as did also the age, weight and sex of the patients, and the measure of individual idiosyncrasy. Even this list does not exhaust the disturbing factors present. Many of the cases are very indifferently noted, and important points are slurred over or are altogether omitted.

It is quite obvious that in not a few cases the observers failed for comparatively long periods to grasp the true nature of the patients' troubles, and continued to pile up the doses of quinin when the drug should have been at once and completely withdrawn. Some of the most melancholy of such cases are those in children, in whom it seems to have taken days before it was recognized that the little patients were blind. It is clear that in many of the cases, the onset of acute cinchonism was mistaken for a recurrence or a development of the disease for which the drug was given. If there is one thing that should be written in heavy type across the literature of this subject, it is that quinin poisoning is a condition which can be diagnosed with ease and certainty by the least experienced practitioner, and that mistakes, such as those which abound in these records can and should be erased from medical experience.

The administration of medicinal doses (10 to 15 grains) of a salt of quinin gives rise in normal subjects to a train of symptoms, which is so constantly met with and of such slight clinical significance, that it is best described under the term "cinchonism"; reserving that of "quinin poisoning" for the more serious form of the same condition, which attends the ingestion of large doses, or that of comparatively small doses in very susceptible subjects.

Cinchonism. Soon after taking the quinin, the patient complains of

ringing in the ears, deafness and a feeling of fullness in the head. Headache, which may sometimes be very severe, may be experienced. Giddiness may supervene, and the patient may even stagger in his walk. Often he will wish to lie down, and, feeling drowsy, he may quickly fall asleep. All these symptoms are transitory and as a rule have passed away completely the next day; always provided, of course, that further doses of the drug are withheld.

Quinin poisoning. In a very large number of the recorded cases in which a single large dose was given, the signs of this condition are described as coming on "the next day"; or "after the patient awoke" from a heavy sleep, or from a comatose condition which followed the dose. There can be no reasonable doubt that the real evidence of the quinin intoxication was forthcoming much earlier, had it been looked for, but was missed owing to the patient's drowsy condition, or because it was not anticipated. Often, the striking symptom that first arrests attention is partial or complete blindness. The accompanying deafness is usually made less of, because as a sign of cinchonism it is so familiar as to have bred contempt. When the drug has been more gradually administered, failure of sight may again be the first sentinel symptom. As will be seen later, the interference with vision may be noticed within the first half-hour or even quarter-hour, and may steadily and rapidly deepen.

Diminution of central visual acuity. The onset of central blindness is so striking a symptom that it compels the attention of the patient in a way that no other does. If one were to judge from the text of the reports alone, one might reach the conclusion that the onset of blindness was often sudden. If a surgeon were on the lookout for the well known symptoms from the first, it seems more than probable that he would find the loss of sight heralded by amblyopia and contraction of the field of vision. This has certainly been the case in a few instances, where close observation was possible.

Much depends on the dose and method of administration of the quinin. When a single large quantity of the drug has been taken, interference with vision has been noted in a few cases in from a quarter to half an hour (de Schweinitz, Kalebiakin's three cases, Manolescu, Myer); a number of other observers are content to describe the blindness as coming on "soon after" the dose was taken (Harbridge, Nettleship, Roosa, Trousseau and Pidoux, Underhill and von Speyer). In one of Weeks' cases, in which the dose was very large, the period mentioned was three hours; in Schwabe's patient five hours elapsed, but the dose was here under 20 grains.

In these patients who first notice blindness on awaking next morning,

or on recovering consciousness after several days of coma, it is impossible to say when their symptoms commenced. In considering the patients in whom the administration of the medicine was spread over a number of days, it is much more difficult to obtain anything like scientific accuracy, but it is quite clear that in them the drug produced a cumulative effect.

In saying this, it is not implied that the concentration of quinin in the blood increased steadily, for such a suggestion would be contrary to the known facts, but rather that the continued toxic action sufficed in time to bring about a condition of blindness which comparatively large earlier doses failed to do. It is of interest to note that in two cases, the final extinction of vision was instantaneous; so much so as to suggest sudden vasomotor constriction as its cause. Thus, Browne's case said his "sight went out as if you had turned out the gas," while in Michel's patient it is recorded that "vision suddenly went out."

The development of the blindness, from the moment of its first appearance until it became complete, varied enormously. A few never attained to complete amaurosis but were seriously alarmed by the degree of their amblyopia. Cargill's patient could not find her way about her room; whilst Welton's patient stumbled over objects on the floor and complained of hazy vision. In a number of the worst instances, complete amaurosis appears to have been very rapidly established. There can be but little doubt that a large number of cases, in which a moderate amblyopia is present, fail altogether to be recorded or even to attract attention.

Then again, the duration of the blindness varied enormously. In a few, it had begun to pass off in from 14 to 24 hours (de Schweinitz, 14 hours; Schwabe, 19 hours; Keiper, 22 hours; Harbridge, 24 hours). In a number of others the period varied from 2 days up to 2 weeks (Underhill, 48 hours; Collins, Kaz and M'Gillivray, each 3 days; Weeks, 4 days; Manolescu and Weeks, each 5 days; Ayres and Tyson, each 7 days; Parker and Williams, each 8 days; Bruns, 13 days, and Behse, 2 weeks). A few still longer cases are on record, in some of which the exact date is not specified (Shahan, 18 days; Michel, 32 days; Reina, 8 weeks; Voorhies, 10 weeks, whilst in Calhoun's case the patient was lost sight of still totally blind 10 weeks after the dose). In some of the animals he experimented on, de Schweinitz found the loss of vision still total at the expiration of two months.

It is one thing to estimate, as we have just done, the period at which vision commenced to return; it is quite another to determine when full sight was restored. A careful survey of the records cannot fail to suggest the gravest doubts as to whether complete restoration of

vision ever occurs in an amaurotic case. The question is largely one of degree, of the care with which the examination is made, and of the standard accepted as "perfect vision." This will be taken up more fully under the headings of light sense, and of the fields of vision. Meanwhile we may mention that in one of Kalebiakin's cases, the complete restoration of vision was said to have been "almost immediate." Manolescu and Zani each reported full recovery in 14 days; Nettleship in 3 weeks; Kalebiakin in 1 month; Underhill and Williams each in 6 weeks; Parker in 3 months; Brown in 4 months; Weeks in 1 year, and Tyson in 14 months.

In addition, there are a number of records of even longer periods, but it is probable that these represent the times at which the cases were again seen, rather than those at which recovery could have been claimed to have occurred. A very interesting feature of some of the cases is that vision improved up to a certain point, and then went back again. A late second improvement may again be noted (Demichieri, Goldzieher, Kirkpatrick, Mellinger, Michel, Roosa, Ely and Weeks). Finally, it remains to mention that the records clearly show that in a large number of the cases a visual acuity of 6/6 was never reattained, whilst the silence on this subject of many of the reporters is still more significant. Even if central vision be alone accepted as the basis of our judgment, which it obviously should not be, the writer is at wide variance with the optimistic views of Manolescu as to the ultimate restoration of vision after quinin amaurosis. The reasons for this opinion will be better appreciated after a perusal of the next few sections.

Alterations in light sense. It seems probable that a defective light sense would have been found in quite a large number of the patients, who have suffered from quinin amaurosis, if only the examination had been sufficiently careful and exhaustive. It is significant that our sources of information on this head come from the observations of comparatively few writers, most of whom were ophthalmologists of exceptional note. It is quite obvious that in the majority of the cases, no careful estimation of the light sense was made; indeed, the possibility of a defect in it does not often seem to have been taken into account. In any case it would be difficult to estimate such a defect in the early amblyopic stages, and nearly all the notes refer to a late period of the affection. An exception to this rule is found in Nettleship's patient, who "found he could stare at the sun without inconvenience" shortly after the commencement of return of vision. Two months later, he complained of seeing badly in a bright light, and of a mist before his eyes in the early morning. Weeks observed a marked

diminution in light sense in both of his cases of quinin poisoning. One of his patients complained bitterly of reduction in this sense up to the day of her death; whilst in the other light perception was diminished and light adaptation slow 35 years after the origin of the poisoning. Roosa and Ely's patient was reported 3 years after the intoxication, as never having seen well since she took the quinin. She "felt as if a veil were over her eyes." de Schweinitz' patient was markedly night-blind after 8 months, and his light sense was reduced to 0.6 of the normal. Welton's case resembled this in being badly nyctalopic after 2 years; although it was doubtful whether he had ever been absolutely amaurotic. Other instances of damaged light sense are recorded by Ayres, Bruns, Manolescu, Panas, Parker, Schwabe, Shahan, Williams and Zanotti.

Alterations in the visual fields. A constriction of the visual fields is probably the most constant sign of quinin poisoning of the eyes. As the amaurosis or amblyopia passes away, it is found that the patient is considerably hampered by the loss of his peripheral vision. He stumbles over objects on the floor, or has difficulty in finding his way about a room. This defect continues when the central vision, as measured by the test types, has returned to normal, and may give rise to very grave inconvenience. On the other hand, when the dose has been comparatively small, rapid improvement may take place, and after a period of months or even of weeks, the recovery may be so great as to lead the patient and his medical adviser to believe it perfect. Without denying that such a happy result may sometimes be attained, it is quite certain that such cases constitute the exceptions and not the rule. In a very large number of instances, a permanent and often progressive reduction of the visual fields has been recorded. This is sometimes so extreme as to constitute "tube vision" (de Schweinitz, Kalebiakin, Schwabe, Tyson, von Kubli, von Speyer, and Weeks), whilst in quite a large number of cases the defect, though less extreme, is yet well marked.

Improvement may go on taking place for months and apparently even for years (Tyson and Weeks). On the other hand, the fields may enlarge up to a certain point and then become narrowed again. It is possible that these secondary deteriorations are due to the unwise administration of quinin on a later occasion, as happened in Weeks' case; or to the abuse of some other toxic drug, such as caffeine (Schwabe).

Calhoun has recorded the case of a prominent physician, who found that 10 grains of quinin made him amblyopic, whilst repetitions of the dose caused alarming symptoms. The writer has under his care a

man of 60, in whom a dose of 3 grains of quinin will at any time cause marked constriction of the field. It is probable that such cases as those above quoted explain the late deteriorations of the fields which are on record, but it is of course quite possible that the latter may occur independently of the administration of toxic drugs.

It has from time to time been suggested that the typical visual defect in quinin poisoning leaves a horizontally elliptical field, the upper and lower areas being more encroached upon than the lateral ones (Harbridge, Knapp, M'Gillivray and Welton). Again, it has been suggested that one area of the field, as the temporal or the nasal, tends to clear up sooner than the others. A survey of all the records lends little support to such suggestions, the contraction being apparently usually concentric. Some very anomalous fields have been noted; thus Mosso described a paracentral scotoma, which was first absolute, later relative and finally annular; whilst Bietti, Galezowski and Jodko all record instances of central scotomata.

Alterations in the perception of colors and in color fields. In those cases in which the central color vision was tested at a very early stage, it would appear to have been uniformly deficient or absent. Improvement, however, set in fairly early in most cases. In some, the central color vision again became perfect (Browne, Bruns, Cargill, de Schweinitz, Schwabe and Williams). In others, the recovery was less complete (Keiper, Tyson and Williams). Shahan's case was totally blue-green blind after 3 months. One of Weeks' cases was green-blind after 2 years, but a second small dose of quinin had been given in the interval. Knapp's patient was at first totally color blind. This gave place to red-green blindness, then green and grey were confused, and finally, at the end of five years, complete color perception was re-established. The extraordinary variability in the course of the recoveries is illustrated by comparing the last case with that of Cargill, whose patient could not distinguish colors on the ninth day, but could do so on the forty-fifth. Still more striking is Schwabe's case, in which there was no color vision 43 hours after the dose, while on the 5th day, the central color perception was good. The notes on the state of the color fields are scanty, but they were reported to be greatly contracted by Browne, de Schweinitz, Stasinski and Welton.

Dilation of the pupil. In the great majority of the cases of quinin poisoning the pupil is described as being fixed and dilated, the latter often to an extreme degree. No observations appear to have been made as to the exact time when the pupil begins to enlarge, but from his observation of a very susceptible case, the writer thinks that this probably takes place at a very early stage. It is a phenomenon of the

greatest importance, inasmuch as it enables even one who is not an expert to get a good and easy view of the fundus. The combination of a dilated pupil with the typical ophthalmoscopic appearances should leave no doubt as to the rôle of the drug in the causation of blindness. As the case progresses, and the patient recovers vision, the extreme dilation of the pupil passes away, and the normal movements are reestablished.

But it is probable that some enlargement remains permanently in quite a number of the cases, nor is it certain that the movements wholly regain their former activity and rapidity. In Cargill's case the pupils reacted slightly to light and accommodation on the thirty-eighth day, and well on the seventy-eighth. The pupils were slightly dilated and the iris reaction was sluggish in Reina's patient, 6 months after the poisoning. The same held true for the right eye in Kirkpatrick's very interesting case, nearly a year after the dose was taken, whilst the left eye showed a widely dilated and fixed pupil. A similar state of affairs has been recorded after still longer periods, viz., 1½ years (Harbridge), 2 years (Welton), and 5 years (Knapp). In Bruns' two cases there was slight dilation of the pupil 10 and 17 years respectively after the poisoning.

A few points of interest remain to be recorded. In Knapp's case above mentioned the pupils responded to accommodation but not to light. In Hobby's patient, the pupils though widely dilated, reacted to eserine. Contraction instead of dilation of the pupil has been described by Roberts, whilst Shahan noted active elliptical pupils on the 18th day after a very large dose of quinin had been taken.

The ophthalmoscopic changes in quinin amblyopia. The most characteristic of these are pallor of the optic discs, and extreme contraction of the arteries and veins of the retina. These two phenomena recur with monotonous regularity in all the reports. The appearance of the nerve head is such as to suggest advanced atrophy; the pallor is striking, and the edges of the disc stand out by contrast with great sharpness against the surrounding fundus. The retinal blood supply is so greatly diminished that its vessels, and especially its arteries can sometimes be traced but a very short distance out from the disc edges. The next most frequent of the signs observed have been those of a cherry spot at the macula and of retinal edema (Berger, Buller, Gruening, Reina, Seligsohn, von Speyer, Weeks and Zani). Reina and Weeks differ from the other observers in describing the macula as reddish, and as brownish-red respectively. Weeks explains this peculiarity in color as due to the absence of edema at the fovea. He points out that the absence of the vivid cherry color, found in obstruc-

tion of the central artery, is due to an ischemia of the choroid as well as of the retina, the former resulting from the action of quinin on the choroidal vessels. The absence of a free flow of arterial blood, in his opinion, causes the fovea to lose much of the vividness of color it would otherwise possess. Nettleship, in a case seen two months after the poisoning, found a certain degree of retinal edema, whilst Gruening observed the characteristic macular phenomenon and the surrounding edema disappear in 9 days. A few surgeons have recorded a thickening of the arterial walls presenting itself in the form of white streaks which run along the vessels (Bruner, de Schweinitz, Moulton, Parker, Reina, Seligsohn, Terrien and Aubineau, Uthoff and von Speyer).

Fundus changes, indicative of inflammatory action, have been recorded by a few observers. These include retinal changes (Buller, Demichieri, Keiper, Parker and Zanotti); hazy edges to the papillæ (Ballantyne, Bietti and Roberts); and choked disc (Dickinson, Zani and, doubtfully, Terrien and Aubineau). The columns of blood in the retinal vessels were observed to be broken in Parker's case; and retinal arterial pulsation was recorded by Buller and Manolescu; Parker reported a thrombus in a branch of a retinal vein in each eye; Kirkpatrick found one nasal artery in each eye much thickened, almost obliterated and partly covered by a hyalin mass as it crossed the edge of the disc. It is possible, if not probable, that some of these rarer changes are accidental, and have no connection with the quinin poisoning.

There is a point of very great interest, which we shall merely mention here, viz., that there are indisputable cases on record, in which quinin amaurosis is present in the absence of the characteristic ophthalmoscopic appearances which we associate with this condition (Ballantyne, Webster Fox, Garofolo, Hamlich, Jodko, Kaz, Mantendam, von Graefe and Wilbrand). This observation increases in interest from the fact that a similar experience has been met with in dogs (de Schweinitz).

Unusual eye symptoms in quinin amblyopia. The following unusual phenomena have been met with:

Unilaterality of the affection (Browne, Hobby, Kirkpatrick, von Graefe and Westhoff). These cases all differed from one another, but at the same time had this in common that some one or more of the features of the condition (dilatation of the pupil, ophthalmoscopic appearances, central visual acuity, visual fields, etc.), were better marked in one eye than in the other.

Alterations in sensation. An anesthesia of the conjunctiva was met with by Barabaschew and Belsky, and of the conjunctiva and cornea

by Voorhies, whilst Parker's case presented a hazy and hyperesthetic cornea. Both Barabaschew and Parker noted hypotonus associated with the above conditions. In Stasinski's case also a lowering of the ocular tension was present. Tiffany records a case with hypotonus.

Affections of the muscles. Atkinson observed lid spasm; Browne, Claiborne, Diez, Gimlette, Knapp, Peña and Wilbrand record evidence of paresis or paralysis of the ocular muscles; Mosso met with paresis of accommodation. Nystagmus was observed by Jodko, Knapp, Roosa and Williams; in Knapp's case it was vertical and vibratory and was associated with periodic divergence of the right eye. de Schweinitz also observed nystagmus in animals poisoned by quinin.

Aural symptoms in quinin amblyopia. Deafness is an early and troublesome sign of quinin poisoning. As a rule, it passes off quickly and completely. Williams, however, records a case in which the hearing was never wholly recovered, and it seems likely that many more such have been missed. In view of what has been found in connection with vision, and bearing in mind the similarity of the attack by quinin on these two special senses, one cannot help thinking that, if the hearing of a number of these cases were very carefully tested, evidence would be forthcoming of some permanent damage in a definite percentage of them. With the deafness is associated a variable and often distressing amount of tinnitus, and a feeling of fullness of the head. More rarely there is definite headache, which occasionally may be extremely severe. Giddiness, or dizziness, makes a not very infrequent appearance in the notes, though probably it is a symptom, which is often missed, or belittled. It remains to mention Welton's very unusual case in which there was no tinnitus or deafness, and in which the patient's mental condition remained clear, although the vision was profoundly affected. Roosa and Ely's experience was allied to Welton's, inasmuch as aural symptoms were conspicuous by their absence, but on the other hand, delirium was present.

The pathology of quinin poisoning. One of the earliest, if not actually the very earliest, of the communications on this subject is that by Brunner (1882), who discussed the mechanism of quinin blindness and suggested the following possibilities: (1) That the alkaloid in the blood directly attacks the end organs of the retina; (2) that the retina is starved owing to the ischemia; (3) that the optic nerve is primarily attacked; (4) that the blindness is due to gross lesions, either inflammatory or hemorrhagic; (5) that the primary lesion is cerebral in origin. After a careful consideration of the question, he came to the conclusion that the seat of the lesion was a peripheral one, and that the amaurosis was dependent upon the retinal ischemia,

though inflammatory changes of the retina might play a secondary part. Ten years later, de Schweinitz experimented on the same lines (without knowledge of Brunner's work), and carried the matter still further by producing quinin blindness in dogs, and submitting the brain and eyes of the animals to careful anatomic examination. In the main, he confirmed Brunner's findings, but was disposed at the time to lay some stress on inflammatory changes in the walls of the vessels of the optic nerve. He thought that the vasoconstriction was due to the action of the quinin upon the vasomotor centers, and he drew special attention to the selective action of this drug upon the special sense organs of sight and hearing.

About the same time (1891) Barabaschew made a contribution to the subject which was as venturesome as it was interesting, since his experiments were made on human beings. With doses of 0.3 to 0.6 grms. of quinin, he found no observable results in sound subjects free from idiosyncrasy; 1.2 grms. produced annoying symptoms, though not the same in all cases; 2.4 to 3.6 gm. doses resulted in the appearance of marked symptoms, analogous to those of severe quinin amaurosis; these included all the classic signs of the condition. He was able to draw an early clinical picture of extreme interest, and one which for obvious reasons has evaded the attention of the practising clinician. Its leading features are as follows: (1) There is an increase of visual acuity following the dose and lasting for some hours; (2) there is an early constriction of the pupil, which lasts only a short time and then passes into dilatation; (3) the pulse at first is rapid, later it is slow; (4) the sensibility of the cornea is first increased and subsequently diminished; (5) there is an early slight rise of temperature followed by the usual fall. In one case, there was amaurosis for half a minute, which returned ten times after intervals of from 5 to 10 minutes, the sight being normal in between the attacks. Each attack of visual disturbance was attended by a constriction of the visual field. An irregularity of the heart and pulse accompanied these changes and suggested an affection of the vasomotor system. He raised the question whether the contraction of the retinal vessels was a central vasomotor action, or was due to the direct influence of the quinin, circulating in the blood, on the vessel walls. He attributed the contraction of the visual fields to the diminished supply of blood to the peripheral parts of the retina, and to the consequent loss of functional activity in those regions.

Behse injected bichlorid of quinin into animals subcutaneously and found pallor of the optic disc and contraction of the retinal vessels; he was struck by the fact that the dose required to produce toxic

symptoms differs as widely in animals as it does in man. He described changes in the coats of the vessels, and thrombosis of the retinal artery amongst other phenomena, which he encountered. He thought that the primary change was a spasm of the vessel walls, followed later by organic alterations, associated with permanent loss of vision.

A new note was struck by de Bono (1894), who made a number of experiments on frogs. In these animals, there is, under normal conditions, a movement of the pigment granules in the retinal epithelium, as a result of the stimulus of light. De Bono found that if a toxic dose of quinin were first administered by injection, this normal response to the light-stimulus was abolished; he concluded, therefore, that the cells themselves had been directly poisoned by the drug, and proceeding to apply his results to human beings, he deduced that the cause of the amaurosis was not to be sought in the ischemia present, but in the quinin intoxication of the terminal elements of the optic nerve in the retina, viz., the rods and cones. He further pointed out that, inasmuch as the ischemia may and often does persist, long after the return of vision, it is not reasonable to attribute the blindness wholly to it.

de Schweinitz, in 1896, brought out his classic volume on *Toxic Amblyopias*, in the course of which he discussed the pathology of quinin poisoning at length. Again, in his remarks on Holden's paper, he gave it as his opinion that the ischemia of the retina was due to the action on the vessel walls of the quinin circulating in the blood.

Ward A. Holden (1897-98) examined the fresh retinas of quinin poisoned dogs under Nissl's methylene-blue and eosin, and the optic nerves of the same animals by the Marchi osmic-acid staining method. He concluded (1) that the pathologic process was one of degeneration of the nerve fiber and ganglion cell layers of the retina, due to insufficient nutrition determined by the constriction of the retinal arteries; and (2) that this degeneration was followed by an ascending atrophy of the optic nerve fibers, which extended up to their terminations in the external geniculate body and pulvinar of the thalamus. He found no lesions in the other layers of the retina. To his mind the blindness could be satisfactorily explained by the indirect action of the quinin in producing spasm of the retinal vessels, and thus diminishing the nutritive supply of the inner layers, and he questioned any direct toxic influence on the nervous elements.

The next land-mark in the literature of the subject is Birch-Hirschfeld's paper in 1900. He found that the doses, which were on record as producing quinin amblyopia, varied from 0.75 grms. up to 30 grms. He thought that Holden's findings of changes in the ganglion cells

were not wholly correct, and that an element of confusion had been introduced into them by postmortem changes. His examination showed the following alterations in the cells of the retina: The ganglion cells were shrunken; their boundaries were indistinct; the protoplasm stained deeper than normally with thionin; vacuolation was present, and there were changes in the chromatin bodies, as well as in the nuclei and nucleoli. The inner granular layer showed similar changes, and so did the outer granular layer, but they were less marked in the latter than in the former. The rods and cones were degenerate. There were no changes (endovascular or thrombotic) in the retinal vessels. He conducted experiments by merely cutting off the vascular supply of the retina by surgical means, and compared the results obtained with those following the ischemia of quinin poisoning. The vacuolation of the retinal cells was much less marked in the former than in the latter eyes. On the other hand, the artificial and purely traumatic interference with the blood supply produced much more shrinkage of the cells and of their nuclei than the quinin toxemia did; otherwise the changes were alike in both. He considered that the differences he observed and described were sufficient to indicate that another factor beside retinal starvation entered into the case. In confirmation of this view, he pointed out that it is in accord with what we know of the clinical aspect of quinin poisoning, in its selective action on the special sense organs. Changes in the optic nerve were only observed at a later date and were, in his opinion, merely secondary; he used Marchi's method in his examination of the nerve fibers.

These experiments were criticized in their turn by Drualt (1900), who controlled them by a similar series on quinin-poisoned animals. He found that the primary changes were situated in the ganglion cells, and particularly in those at the periphery of the retina, and he believed that the degeneration in them was due to the direct action of the quinin on the cellular elements, and not primarily to the malnutrition brought about by the ischemia. His argument that the preservation of the fibers, which supply the center of the retina, can hardly be explained on the theory of vascular spasm, is one whose validity many will challenge; for any influence, which lowers the total blood supply to the retina, will surely be most felt at the periphery, where the pressure is normally lowest, and least felt at the center, where it is highest. Drualt's main criticism of Birch-Hirschfeld's technic is on the ground that rabbits are unsuitable subjects for such investigations, since changes are very easily produced in sections of their retina by slight modifications of the method used. Drualt, Abelsdorff and

Nuel have all failed to find the changes, which Birch-Hirschfeld described as occurring in the nuclear layers of the retina.

There are, then, two schools of thought, one of which ascribes quinin blindness to starvation of the retina as a result of the ischemia produced, and the other believes that there is a selective toxic action of the drug on the cells of the retina. Some additional light is thrown on the case by an examination of the clinical records, and by a consideration of certain features of the toxic amblyopias which follow the action of other poisons.

Mention has already been made of cases in which patients have described the extinction of their sight as occurring with dramatic suddenness, and attention has been drawn to Barabaschew's extraordinarily interesting case, in which amaurosis lasted half a minute, and returned 10 times at intervals of from 5 to 10 minutes, the sight being normal between the attacks. It would appear certain that spasmodic vasomotor constriction plays an important part in these cases. Other facts which point in the same direction are: (1) Parker observed the columns of blood presenting a broken appearance in the retinal vessels of his case. (2) Stasinski met with a case of quinin amaurosis, in which vision improved when the patient lay down, and diminished when he sat up. (3) Zanotti had a girl under quinin treatment whose sight suffered each time that a dose of .75 cg. of quinin was given her; at the same time, her discs paled and her retinal arteries narrowed; and (4) the writer recently met with the same sequence of events after a very small dose of quinin in a highly susceptible patient. It would hardly be safe in these two latter cases to argue that the loss of vision was due to the ischemia. They might both be effects of some common cause.

There is, however, a very strong argument against the view that the blindness of quinin poisoning is due to retinal ischemia, and it is to be found in the fact that there are a number of cases on record, in which the retinal vessels were either normal in appearance, or at the most were only slightly contracted, at a time when absolute amaurosis, with wide dilatation of the pupil, had been definitely established. The earliest of such were two reported by von Graefe; since then, others have been recorded by Ballantyne, Browne, Buller, Webster Fox, Garofolo, Jodko, Kaz, Muntedam and Williams. Attempts have been made to discredit this evidence, but it is obviously impossible to explain away so considerable a number of observations made by such reliable and distinguished surgeons, even were they not supported by experiments on animals, as indeed they have been; for, de Schweinitz records a very similar experience in a dog blinded by a dose of

quinin, given the previous day. In this animal there was no evident change in the color of the discs, or in the caliber of the veins; the arteries were smaller than they had been, but their shrinkage was very gradual, and took 21 days to its complete accomplishment; during the whole of this period, the animal was totally blind. Nor was this experience an isolated one, for the same author remarks in a foot-note that "occasionally in dogs, although the blindness is complete, the shrinkage of the vessels does not occur till some days afterwards." Ballantyne has further pointed out that even in ordinary typical cases, there is no close connection between the degree of ischemia and the state of the vision, and that one of the most striking phenomena of quinin poisoning is the recovery of vision at a time when the optic discs are becoming paler and paler, and when the attenuation of the retinal vessels is becoming more pronounced. We must not forget, however, that at a still later stage of months or even years afterwards, the gradual and permanent restoration of vision is accompanied by some measure of visible increase of the retinal circulation. It would be well to avoid laying too much stress on this latter argument; nor should we overemphasize the value of the opposing evidence furnished by Hobby's case, in which, with marked ischemia of both retinae, the vision of the right eye was 0.50, whilst that of the left was only 0.03. In a few days both recovered vision of 0.80. The inequality of the visual power, coincident with the bilateral ischemia, is striking, and would be convincing if we could only be sure that the constriction of the retinal vessels was the same in both eyes; unfortunately we cannot.

Yet another argument is furnished by W. W. Gray, and endorsed by de Schweinitz, for whom he was working. It is that "though the original effect (of quinin on the eye) is in some sense due to the influence of this drug on the vasomotor centers, this cannot be the entire explanation, or we should have similar actions under the influence of well-known vasomotor stimulants like ergot." de Schweinitz describes the signs of ergot poisoning as follows: Wide dilatation of the pupil, blanching of the optic discs and contraction of the retinal vessels.

Whilst the signs and symptoms of quinin poisoning closely ally the action of the drug with that of the many other toxic substances which produce amblyopia, there are distinct features which stamp this toxemia as specific. These are: (1) The absolute completeness of loss of all vision, sometimes coming on quite suddenly; (2) the extraordinary recovery of function which may subsequently occur; (3) the fact that the central vision comes back first, and that the peripheral vision is recovered more slowly and seldom, if ever, completely;

(4) that the color sense is often damaged, but that if it returns, it does so first at the center, and then works gradually outwards; (5) that a diminution of the light sense, with resultant night-blindness, is a frequent, if not an invariable sequence of these cases. No such syndrome occurs in any other form of toxic amblyopia; moreover, as de Schweinitz showed, each of the poisonous drugs, which affect vision, produces more or less specific results of its own, thus suggesting that each acts on definite structural elements, and in a specific manner. Ballantyne suggested the possibility that quinin acts selectively on the rods, and he considered that the night-blindness, so often complained of in these cases, supports this view. Ingenious as the suggestion is, the evidence on which it is based is somewhat sketchy. The weight of the latter would undoubtedly favor the view, that in dealing with quinin amaurosis, we have to do with a specific toxemia, a feature of which is a powerful selective action. As to the precise nature of the structure selected, we are not yet in a position to pass a final judgment. It is obvious that when a retina, or indeed any other organ, is suffering from the effects of a powerful intoxication, the cutting off of its blood supply may become a very important and even a dominating factor in the situation. In other words, the ischemia is not the primary, or the principal cause of the amaurosis, but it is none the less an influence of the gravest possible import and one which we must never omit from our calculations.

Before closing the subject, a word should be said on the parallel that has been drawn between quinin amaurosis and that occurring after hemorrhage. Surgeons have written and spoken, as though the two conditions were indistinguishable from each other, if not identical. Webster Fox has ably dealt with this matter, and has laid the myth to which we have referred. In 106 cases of blindness following hemorrhage, he found that the clinical picture of a pure ischemia without inflammatory changes was invariably absent; restitution of normal central vision did not occur; nor was the syndrome of sudden deafness and blindness ever observed as a result of a severe hemorrhage. Dealing with this subject, Fuchs gives acute anemia, after great loss of blood, as a cause of optic neuritis, and he states that hemorrhage from the stomach and uterus are the most frequent causes of the condition; the blindness does not set in until some days after the hemorrhage and is generally incurable.

Treatment of quinin blindness. The first and most obvious indication in the treatment of quinin poisoning is to stop the supply of the drug. There is, however, a tendency amongst a certain school of practitioners to argue that blindness is preferable to death,

and that therefore the treatment of malaria will sometimes demand the sacrifice of sight in order to save life. Those who adopt such a position must see to it that their diagnosis is correct, and that the symptoms, which they ascribe to malaria, such as vomiting, headache, delirium and coma, may not in reality be manifestations of quinin poisoning. They must also satisfy their colleagues, that there is no method of effectually treating severe cases of malaria other than the exhibition of the large doses of quinin which they advocate. The writer does not attempt to dogmatize on the latter subject, but he is skeptical as to the favorable reception of such a view by those who have had large experience in the treatment of tropical diseases.

Once a patient is known to have an idiosyncrasy for quinin, or to have suffered from poisoning by this drug on some previous occasion, it is advisable to avoid the exhibition of any of the cinchona products, if possible. It has already been pointed out that in the experience of de Schweinitz, Knapp, Nettleship and others, patients, who have already suffered from poisoning by large doses of the drug, are liable to be adversely affected on subsequent occasions by comparatively small ones. Manolescu, not merely lays great stress upon this point, but urges that the greatest care should be taken in the use, under such circumstances, of any product, which is known to be liable to bring about any form of toxic amblyopia. The lesson he teaches is strongly reinforced by Schwabe's experience, which we have already quoted at length.

Passing from negative to positive measures, are the drugs which have been recommended by different writers. By far the most popular of all these is strychnin (Baldwin, de Schweinitz, Jodko, Kirkpatrick, Parker, Reina, Weeks and others). de Schweinitz ascribes its value to direct stimulation of the optic nerve fibers, but it seems possible that this may not be the whole cause of its favorable influence. It is said to prove more satisfactory when injected subcutaneously.

Next are the drugs which favor vasodilatation, and of these, nitrit of amyl has been the most used (Baldwin, Kirkpatrick, Parker, Reina, Weeks and others), while nitroglycerin has had only one advocate (Parker). This is the more incomprehensible since the action of the former drug is well known to be very transient, whilst that of the latter is slower and more lasting. These characteristics, seemingly, would have recommended nitroglycerin. It may be mentioned that Parker combined the two, giving 2 minims of nitrit of amyl thrice daily, together with 1-75th grain of nitroglycerin every 4 hours. Digitalis has appealed to a number of the writers (Buller, de Gouvea, Gruening, Tiffany, Weeks) presumably because it increases the force

of the heart beats. The bromides and iodides have both been called into requisition, but do not appear to have attained to any great popularity. Webster Fox, however, claims to have obtained great improvement under treatment of a severe case with hydrobromic acid. He gave 15 minims thrice daily to a boy of 13, who had been given large doses of sulphat of quinin for a long period. In a case with high tension Tiffany used eserine, not unmindful of the advantage obtained by its action on a dilated pupil.

Reina used massage, presumably because the appearances present sometimes resemble those of embolism. It is doubtful whether such a proceeding is of the least value, the more so as it appears to be founded on a mistaken view of the pathology of the complaint. Galvanism has been recommended by Weeks and Buller. Its value, too, is questionable. Kirkpatrick employed Bier's suction-glass. Weeks and Baldwin have suggested keeping the patient recumbent. This recommendation is supported by Stasinski's case already mentioned, in which the vision of a quinin-poisoned patient improved each time he lay down, and diminished when he sat up.

As to the general management of the patient, von Graefe's recommendation in favor of bleeding has deservedly met with universal condemnation. Weeks sums up the indications as follows: The relief and prevention of vascular constriction by the use of drugs, etc.; the adoption of vigorous supporting measures inclusive of a generous diet and plenty of fresh air; the insistence on the recumbent position with the head low for the first ten days, in order to favor a freer flow of blood through the retinal and choroidal vessels. It remains only to mention Manolescu's jeremiad, in which he claims to have tried every possible measure in turn and to have found all equally useless.

Operative treatment of quinin amblyopia. Elliot believes there can be no question that the constriction of the retinal vessels plays an important part in the pathology of quinin amaurosis. A recognition of this fact has led ophthalmic surgeons to employ such drugs as nitrite of amyl and nitroglycerin. If the intraocular pressure could be permanently reduced by operative measures from normal to subnormal limits, it seems reasonable to suppose that the flow of blood through the eye would be increased; under these circumstances, an improvement in retinal function might be anticipated. It was on such lines as these that Mayou recommended sclero-corneal trephining in the treatment of retinitis pigmentosa. The same operation seems worthy of trial in some of the permanent cases of quinin amaurosis, in which the visual defects are associated with the ophthalmoscopic signs of severe constriction of the retinal vessels. The way in which contracted

visual fields have been found to improve, even after the lapse of years, would seem to indicate that something might be done in very late cases.

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[See, also, references in the text.]

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Rattlesnake venom. See p. 10881, Vol. XV; also **Snake bite**, and **Serpents** in this *Encyclopedia*.

Resorcin. Hirschberg (*Centrabl. f. pkt. Augenheilk.*, Dec., 1886) has reported a case of conjunctivitis after application of an ointment to the face.

Rhus toxicodendron. See **Poison ivy** in this *Encyclopedia*.

Roburite. See *Dinitrobenzol*, in this section.

Safranin. See *Anilin* herein.

Salicylic acid. See p. 3249, Vol. V; as well as p. 72, Vol. 1, and p. 11499, Vol. XV of this *Encyclopedia*.

In a number of cases where heavy doses of salicylic acid or its salts have been employed, a slight and temporary decrease of visual acuity has occasionally been noticed. The disturbance seems similar in character to that seen in the milder attacks of quinin amblyopia.

Several cases of poisoning are recorded from the use of these drugs. An early and important case is that of Gatti (*Couriere Medicale*, 1881). 8 grammes, divided into ten doses—one every hour—were given to a perfectly healthy sixteen-year-old girl for acute articular rheumatism. She slept several hours after the last dose and when she awoke was absolutely blind, or had only qualitative perception of light; marked mydriasis, clear media, light gray reflex, papilla normal, edges well defined. Retinal veins filled with blood. No phosphenes. Deafness, weak cardiac impulse, small pulse, slight perspiration; pains in joints entirely gone. Urine normal. In it no trace of salicylic acid. Dullness in head, sleepiness, memory unclouded. Ten hours later patient awoke from sleep and was able to count fingers, but the deafness and mydriasis lasted until the next day. Vision finally became normal.

Somewhat earlier, says de Schweinitz (*loco cit.*, p. 205), than this observation by Gatti is one by Riess (*Berlin. klin. Wochenschr.*, 1875, xii., pp. 673, 690), who, in his researches on the effect of salicylate of

sodium on healthy people, noted tinnitus aurium and disturbance of vision after 5-gramme doses.

Knapp (*Bericht ueber die Versammlung der Ophthalmologischen Gesellschaft*, Heidelberg, 1881, xiii., p. 103), describing quinin-blindness, states that he has seen three cases presenting precisely analogous symptoms due to large doses of salicylic acid and salicylate of sodium.

Evidently an amblyopia in all particulars resembling that produced by quinin may result from large doses of salicylic acid or one of its salts.

Salvarsan. Arsphenamin. Arsenobenzol. See the major heading **Salvarsan** in this *Encyclopedia*, where the oculotoxic effects of the drug are to some extent discussed. Here it may be said that Wernicke (*Zeitschr. f. Augenheilk.*, May, 1913) reported 10 cases of *optic neuritis or neuroretinitis after injections of salvarsan*, of which at least nine were likely due to the drug, or were not prevented by it. The specific action of mercury in these cases rather indicated the luetic character of these relapses. Since the introduction of salvarsan no case of neuritis has been observed after mercurial treatment, so that the frequency of the neuro-relapses after injections of salvarsan cannot be merely accidental. As bearing on the toxicity of the agent, in the summer of 1912 a death was observed at Odessa after an injection of salvarsan. Since then injections of salvarsan have been almost entirely discarded, and no case of optic neuritis has been observed, nor one after mercury. The author emphasizes that, in spite of this, Wernicke thinks that salvarsan acts well and rapidly in many severe cases and frequently surpasses mercury. In ordinary cases, it will not replace mercury and iodine, but should be used in failure or intolerance of the old specifics, and in affections in which no time is left for awaiting the effect of mercury. Salvarsan is no substitute for mercury, but a last refuge. A case of parenchymatous keratitis and one of paralysis of the abducens are reported, in which salvarsan had no effect, whereas, a case of syphiloma of the ciliary body healed after injection of salvarsan in less time than mercurial treatment would have taken.

Twenty-eight cases of grave toxic lesions of the uveal tract and the cranial sensory nerves following the therapeutic use of arsenobenzol are described by R. Arganaraz (*Archiv. de Oftalmol.*, June, 1915) and the following conclusions are presented: 1. Post-salvarsan optic neuritis, whether it be of syphilitic origin or from arsenic poisoning, is aggravated by injections of arsenobenzol. 2. In patients attacked by optic neuritis, the therapeutic use of salvarsan is contra-indicated. 3. Optic neuritis, being of slow evolution and without suggestive symptoms at the commencement, ophthalmoscopic examination of the

fundus of the eye is called for before submitting the patient to salvarsan medication.

Salvarsanized serum. See p. 11502, Vol. XV of this *Encyclopedia*.

Santonin. See p. 2200, Vol. III; as well as p. 2391, Vol. IV and p. 11053, Vol. XV of this *Encyclopedia*.

This drug, together with picric acid, amyl nitrite and occasionally digitalis, might be grouped together as good examples of poisons producing colored vision—generally xanthopsia or yellow vision. Various theories have been put forward to account for these color disturbances. Helmholtz thought they were the result of the direct action of the drugs on the nervous elements of the retina; these being first excited and then exhausted and the eye becoming violet-blind. On the other hand it has been claimed that they are due to the optic media being tinged yellow or green, as the urine is in such cases. The aberration of the color sense was first observed by Hufeland in 1806 and is probably the most marked subjective symptom in santonin poisoning. It has been observed that the usual xanthopsia is often preceded by a violet hue over all objects.

De Martigny in a few cases found the yellow sight intermit and pass into other colors. A dose of 0.3 gm. was followed by xanthopsia; an additional 0.6 gm. dose brought on erythropsia or red vision which became orange and finally yellow. In another patient there was green vision and in one case, blue. We are consequently inclined to believe that the color symptoms are the result of nervous irritation and are not due to light passing through colored media. Dunoyer mentions a case where the patient took .05 gm. santonin. This was immediately followed by aphasia, and yellow vision, both of which disappeared after four hours. This and many other examples show the transitory character of the colored vision.

Saponin. One case of intoxication from this agent (a white, inodorous, sweetish-acid, glueoside, derived from *Saponaria officinalis*) is claimed as a cause of toxic amblyopia. This followed the use of the drug upon the person of Fr. Keppler who was at the time experimenting with saponin for the purpose of determining its value as a local anesthetic. The symptoms were very severe pains, strabismus and exophthalmus of the left eye.

Saturnism. See *Lead-poisoning* in this section.

Sausage poisoning. Consult p. 11548, Vol. XV, as well as **Botulism** in this *Encyclopedia*, and the same caption in this section.

Scammonium. See **Scammonium** in this *Encyclopedia*.

Schweinfurth's green. See p. 605, Vol. I of this *Encyclopedia*.

Scopolamin. See p. 435, Vol. I; as well as p. 2201, Vol. III of this *Encyclopedia*.

Silver nitrate. See p. 11778, Vol. XV; see, also, **Argyrosis oculi**, in this *Encyclopedia*.

Silver salts. These produce, among the other symptoms of argyria, an amblyopia closely resembling that of lead (Gowers) but cases are rare, and since the internal administration of silver compounds is nowadays extremely uncommon, cases of weakened vision from these drugs are practically unknown. Bresgen describes a case of visual disturbance caused by nitrate of silver, but Ulthoff does not think that it was a genuine case of toxic amblyopia. Rumer (Gowers' *Med. Opth.*, p. 279) found deposited in the sclerotic sheath of the optic nerve small, round globules of metallic silver.

Snake bite. Consult p. 11974, Vol. XV; as well as **Rattlesnake**; and **Serpents** in this *Encyclopedia*.

As Casey Wood has indicated, the *venom* of poisonous reptiles may be a cause of blindness in those who survive the action of the poison. In the case of poisonous serpents we have Amaral's assertion that in South America blindness as the result of snake bites is common enough.

de Magalhaes of Rio reports the following case:

A twenty-four year old negro was bitten by a snake. This was soon followed by great weakness, loss of consciousness, rupture of blood vessels and bleeding from the nose. After twenty-four hours consciousness returned, but headache and sleeplessness set in and lasted a month. Then failure of sight was noticed. In another month all symptoms disappeared except the visual disturbance which got worse, and then remained stationary for a year. Finally it went on to blindness. "The eyes are now in constant motion (nystagmus) so that an ophthalmoscopic examination is difficult, but the optic nerve is not atrophic; on the contrary the veins are hyperemic." On a later examination de M. found a round black spot on the outer-upper side of the left papilla which looked like an old hemorrhage.

The active agent in all these cases is an albuminoid substance. Weir Mitchell named the poison of our rattlesnake *crotaline* and said that its virulent qualities resist the influence of temperatures between 0° and 212° F., as well as most antiseptic agents. The poison of the cobra applied to the eyes of fowls acts as a powerful cycloplegic. In a case of amblyopia following "toad" poison getting into a woman's eye, Staderini and Addario found that a one per cent. collyrium of the poison produced anesthesia of the cornea and conjunctiva lasting four to five hours.

Soamin. Consult p. 1130, Vol. II of this *Encyclopedia*.

Sodium bromide. See *Bromism* herein; also p. 2200, Vol. III of this *Encyclopedia*.

Sodium salicylate. Consult p. 12000, Vol. XV of this *Encyclopedia*; also *Salicylic acid* herein.

Spigelia marilandica. *Pink-root.* The root of this plant is very toxic, the eye symptoms resembling those from belladonna.

Spirasyl. Consult p. 607, Vol. I of this *Encyclopedia*.

Stovain. See **Rachistovainization** in this *Encyclopedia*.

Sublimate. See *Mercury bichloride* in this section.

Sulphonal. Eye symptoms from this much used drug are very uncommon. Two histories are of interest. Knaggs publishes the earlier case in which, in addition to general anesthesia, loss of sensation in the conjunctiva was noticed. Dillingham reports a case of intoxication where a temporary ptosis, lasting two weeks, formed a principal symptom of the poisoning.

Sulphur. Sulphur ointment (vaseline 100, wax 5, sulphur 10), applied for eighteen years, is said by Eichbaum to have produced, with other symptoms, an amblyopia of the atropine type.

Sulphur chloride. See *Carbon disulphide*, in this section.

Sulphuric acid. This is a rare cause of visual disturbance. Salomonsohn reported a case of acute polioencephalitis superior (produced by poisoning from this acid) which in its turn caused progressive paralysis of the eye muscles, ending in complete ophthalmoplegia. The patient recovered and the eye symptoms disappeared. Georges Martin also published an instance of blindness, the result of sulphuric acid poisoning.

Sulphuretted hydrogen. Wood remarks that this is one of the very rare causes of amblyopia. Although a violent poison in its undiluted form, it does not seem to exhibit its poisonous qualities upon the eye when breathed in its dilute state, as in illuminating gas, emanations from sewers, springs, etc. In a case reported by P. L. Brouardel this poison produced mydriasis, exophthalmos, loss of pupillary reflex, anesthesia of the cornea, etc.

Tea. *Thein.* de Schweinitz (*loco cit.*) remarks that tea-tasters may suffer from visual disturbances, and a discussion of this subject will be found in the London *Lancet* for 1887. Wolfe (*British Medical Journal*, 1879, ii., p. 328) described fluidity of the vitreous and numerous floating opacities as the result of excessive tea drinking; but the etiological relation of tea to these lesions seems highly improbable. So good an observer as Berry, in relating the causes which he believes potent in the production of toxic amblyopia in general, men-

tions tea. He does not, however, give more definite information than is contained in the words, "I have suspected tea."

Tetrachlorethane. See **Tetrachlorethane**, in this *Encyclopedia*.

In some cases of "dope" poisoning, which is said to "act on the nervous centers," nervous symptoms have been reported. Willcox (*Lancet*, p. 544, Jan., 1915) quotes Heffter and Kraus, who state that in Germany, where the "dope" contains more tetrachlorethane than the English varnishes, two types of symptoms develop: (1) gastrointestinal and hepatic symptoms, and (2) nervous symptoms. The latter group of patients suffers from tremors, headaches, pains in the limbs, numbness, "pins and needles" of the extremities, loss of knee jerks and excessive sweating.

Koelsch (*Münch. Med. Wochenschr.*, Nov. 16, 1915) also noticed among the more marked cases of tetrachlorethane poisoning various nervous phenomena, as headache, paresthesias in the extremities, tremor of the hands, and paralysis.

Thiosiamin. See **Thiosiamin**, in this *Encyclopedia*.

Thiuret. See **Thiuret**, as well as p. 9047, Vol. XII in this *Encyclopedia*.

Thyroidin. *Thyroid extract.* See **Thyroidin** in this *Encyclopedia*.

Myles Standish (*Retrobular Neuritis from Toxic Action of Thyroidin*, 1914) was one of the first to sound a note of warning about this drug and to point out that its indiscriminate employment for purposes of "reducing" is fraught with danger to eyesight. At the time of writing he was able to find eight cases of retrobulbar neuritis with central scotoma attributable to the use of thyroid extracts.

Henri Coppez (*Archiv. d'Ophthal.*, 1900) reported five cases. These were four women and a man between thirty and forty years of age. They developed the toxemia after using the drug in large doses for some months. They had all lost a large amount in weight, but the only other symptoms were general nervous disturbances. There was in each case a loss of vision in both eyes to 1/10 or less, but not an equal amount in each eye.

Carl R. Hennicke (*Klin. Monatsb. f. Augenh.*, 1911) reported a case in a man fifty-three years of age, first seen in 1907. He had a central vision of 6/9 in each eye, with a myopia of 0.50 diopter. The ophthalmoscope showed the left eye with normal fundus. The right disc was somewhat reddened. The outline of the nerve was not lost. The arteries were very small, veins of normal size. It was a case of myxedema and had been under treatment five years. In June, 1910, vision in the right eye was 6/30. Ophthalmoscopically as in 1907. The patient had taken thyroidin since 1903. He did not return till Septem-

ber 21st. Vision in the right eye was then movements of the hand, and in the left eye was 6/24. The right nerve was white, the arteries scarcely visible. The left disc was swollen and reddened and the outline blurred. The neighborhood of the nerve not clear, the arteries small, and the veins swollen. Iodid of potash was prescribed and thyroidin was omitted, and on November 21st vision in the right eye was 6/30 and in the left 6/18. Hennieke thought the ophthalmic changes were not due to myxedema, but to thyroidin. On January 27, 1911, vision in the right eye was 6/30 and in the left 6/12.

Emanuel Snydercher (*Jour. Amer. Med. Assoc.*, p. 1473, Oct. 28, 1911) noted a case of a woman forty-two years of age who came complaining that in bright light she had difficulty in seeing, all objects appearing more or less hazy; but in a subdued light, or even in comparative darkness, she had no trouble. An ophthalmoscopic examination showed an apparently normal fundus, with the possible exception of slight blurring of the edges of the disc. Vision was 6/9 in each eye.

Perimetric examination disclosed an oval central scotoma for red and green in both eyes. Investigation of her mode of life revealed no apparent cause for this condition. She denied being addicted to either tobacco or alcohol. Repeated examinations disclosed no sugar in the urine, this being a frequent cause of a chronic toxic amblyopia, such as she was suffering from.

Quite accidentally, during a subsequent examination, she volunteered the information that, for a number of months, she had been taking an antifat remedy recommended by a friend. Investigation revealed the fact that this patient had been taking thyroid extract for almost three months to reduce her weight. The thyroid was at once stopped, the patient was given strychnin hypodermically, and in a few weeks the scotoma disappeared.

Aalbertsberg (*Weekbl. v. het. Ned. Tijdschr. v. Geneesk.*, ii, No. 22) reported a case of optic neuritis following the use of thyroid gland in a patient with myxedema who had been thus treated for some time. The effect on the disease was favorable, but the patient began to complain of poor vision in the left eye. Examination revealed optic neuritis. Later, vision failed in the right eye and a low degree of neuritis was found there. The use of thyroid was stopped immediately and the condition of the eye improved. In the left eye, however, an atrophy of the nerve came on.

Standish reports, also, three of his own cases, the first as follows:

On May 7, 1910, a woman, aged sixty-nine years, discovered a short time before that vision in the left eye was not so good as in the right. She had a small central scotoma in the left eye and a central color

scotoma for green in the right eye. Her vision was 6/30 in the right eye and 6/25 in the left eye. About ten days before she had first been unable to read newspapers.

With the ophthalmoscope there was found some slight swelling of the optic disc in the right eye, some narrowing of the arteries, but not marked turgescence of the retinal veins. There were several small retinal hemorrhages in each eye. It was originally a case of myxedema. Formerly she had the enlarged features and club-fingers which are markedly characteristic of the disease. When she came these characteristics had disappeared. She was anemic, emaciated, weak, nervous, and looked like a very sick woman. She had been treated with thyroidin, and after several years' treatment the recovery from the myxedema was considered complete. However, she continued the drug on her own responsibility after ceasing to visit the doctor. For fourteen years she had taken a 5-grain thyroidin tablet three times a day, and for five or six years had taken one tablet each day.

Examination failed to find any disorder of the kidneys, and the physician in charge was inclined to attribute the retinal hemorrhages to her marked anemia. Thyroidin treatment was discontinued and vision improved sufficiently to enable her to thread a coarse needle, but there was a recurrence of the myxedemic symptoms. She died suddenly on July 19th.

Tobacco. Nicotin. Tobacco-alcohol amblyopia. See under **Tobacco** in this *Encyclopedia*, as well as Alcohol-tobacco Amblyopia under *Alcohol, Ethyl* in this section.

In addition to the matter found under these titles and also on p. 301, Vol. I of this *Encyclopedia* the following observations have been made.

The Editor (Casey A. Wood, *The Toxic Amblyopias*, p. 6, 1894) early pointed out that, as in the case of alcohol, the more concentrated the form and the more constantly the indulgence in the tobacco poison, the greater the likelihood that the vision of the *habitué* will suffer.

The writer has not been able to find the report of a case where amblyopic symptoms were developed by snuff-taking. Prepared snuff, it must be remembered, is much poorer in nicotin than the natural leaf tobacco. This is due to the process of manufacture during which a large percentage of the toxic agents is removed.

Now that the use of alcoholic beverages is prohibited in the United States we shall probably encounter more cases of "pure" tobacco amblyopia.

de Schweinitz (*loco cit.*, p. 70) holds that a form of central amblyopia is undoubtedly due to tobacco, no matter how it is introduced into the system. Most frequently amblyopia is caused by smoking

and chewing tobacco, less frequently by the inhalation of its vapors or the contact of the skin with its decoction or its moistened leaves, occasionally by the process of "dipping," and rarely, if ever, by taking snuff.

The susceptibility to the toxic influence of tobacco increases with age, and about the fortieth year the daily quantity of tobacco should be lessened, or disturbances of vision are more likely to arise.

The maximum dose permissible varies from 15 to 30 grammes a day, but it should be remembered that $\frac{1}{2}$ ounce (about 16 grammes) of strong tobacco per week has produced amblyopia.

The toxic effect of the tobacco depends more upon the quantity consumed than upon the quality. Other things being equal, however, the stronger the tobacco the more likely the development of amblyopia.

The method of smoking tobacco appears to exercise a decided influence, the patient being more susceptible if much tobacco comes in contact with the mucous membrane of the mouth, or if the saliva becomes impregnated with it and is swallowed. Inhalation of the smoke increases the potency of the poison, which probably depends for its activities, not alone upon nicotin, but upon a variety of other toxic agents.

Distinctly predisposing causes are chronic alcoholism, and all circumstances which depress the nervous system, particularly lack of sleep, worry, and chronic indigestion.

The disease is much more frequent in males than in females, not because the former are more predisposed, but because they are more exposed to the influence of tobacco.

Certain races, for example, the Turks and Spaniards (island of Cuba), appear to enjoy a comparative immunity from this affection and to withstand the evil influence of excessive inhalation of smoke.

de Schweinitz gives the following main points in the differential diagnosis between various types of central amblyopia:

TOXIC AMBLYOPIA.
(Intoxication-amblyopia.)

History of abuse of alcohol or tobacco; much more frequent in males than females; uncommon before thirty-fifth year.

Visual acuity varies from 5/200 to 20/30.

Scotoma of oval shape stretching from fixation outward, usually not passing to nasal side; generally for colors only (relative), and, if for white, having the general shape described.

Peripheral visual field intact.

NON-TOXIC RETROBULBAR AXIAL
NEURITIS.

History of chilling of the body, excessive exertion, suppression of menses; or of infectious diseases, rheumatism, etc. No special relation to sex or age.

Visual acuity usually greatly disturbed; often complete blindness.

Absolute and often positive scotoma, except in beginning, tending to pass to nasal side of fixation, and not specially horizontally oval in shape.

Peripheral contraction of field for colors and form.

Ophthalmoscopic appearances negative, or a quadrant-shaped atrophy of lower and outer (temporal) portion of disk.	Generally some woolliness of disk, distention of veins; rarely ischæmia of vessels.
General symptoms not characteristic, if present at all; no other eye symptoms.	General symptoms absent, except such as are likely to be present from probable cause.
Slow in onset; usually promptly amenable to treatment.	Often rapid in onset; frequently slow in responding to treatment.

DISSEMINATED SCLEROSIS.

LOCOMOTOR ATAXIA.

SCOTOMATOUS ATROPHY OF OPTIC DISK.

History of exposure to cold, mental distress, overwork, acute diseases, injury to central nervous system, or specific febrile disease; no special relation to sexes; usually appears between twenty and thirty-five years; sometimes in childhood.	History of syphilis common; occasional history of injury; also exhaustion; uncommon in women. Half the cases between thirty and forty years.	Hereditary tendency; history of exhaustion and lack of sleep; usually appears in males before thirty-fourth year.
Visual acuity varies with stage of disorder.	Varies with condition of optic nerve.	Marked depreciation of central acuity.
Central scotoma analogous to toxic variety.	Scotoma at first similar to toxic variety, but progressive.	Scotoma like toxic variety in form, but absolute.
Concentric contraction of visual field; sometimes retention of peripheral borders.	Contraction of the field for colors and form, especially peripheral reëntering angles; often restriction of the temporal half of field.	Often marked contraction of field, especially in hereditary optic-nerve atrophy.
A. General atrophic pallor of disk; B. incomplete discoloration; C. temporal atrophy; D. slight neuritis. (Uthoff.)	General atrophic pallor (gray degeneration); in the early stages grayness of the deeper layers of the disk and undue broadening of scleral ring.	Appearance of optic-nerve atrophy; sometimes slight neuritis.
Characteristic tremor; staccato speech, etc.; nystagmus exceedingly common.	K.j. absent; ataxia; lightning pains, etc.; often reflex pupillary immobility and diplopia.	No special general symptoms.
Very imperfect results from treatment.	Optic-nerve change usually progressive.	Scotoma stationary, but unaffected by treatment.

Statistics of this toxic amblyopia in tabular form have been collected by Scholtz (*Klin. Monatsbl. f. Augenheilk.*, Feb., 1907) from the material of his polyclinic. In the four years from 1900 to 1903, out of 31,583 eye patients, 349 had tobacco-alcohol amblyopia, i. e., 1.1 per cent. According to Lewin and Guillery it fluctuates between 0.365 and 1.39 per cent. The youngest was 25, the oldest 80 years old. It was most frequent in the fifth decade of life. In Hungary, tobacco

plays a more important part than alcohol, as pure alcohol amblyopias are very rare. This corresponds with the relative consumption of tobacco and alcohol in various countries.

While Hirschberg considers 30.00, Groenouw 15.00 as the highest innocuous daily quantity of smoked tobacco, Scholtz found that 25.00 of the cheapest tobacco used in Hungary suffices to produce toxic amblyopia. As these brands contain 4 per cent. nicotin, this means a daily consumption of 1 gm. of nicotin. To this are equivalent 9 cheap or 8 expensive cigars, 10 Havana cigars, or 60 cigarettes.

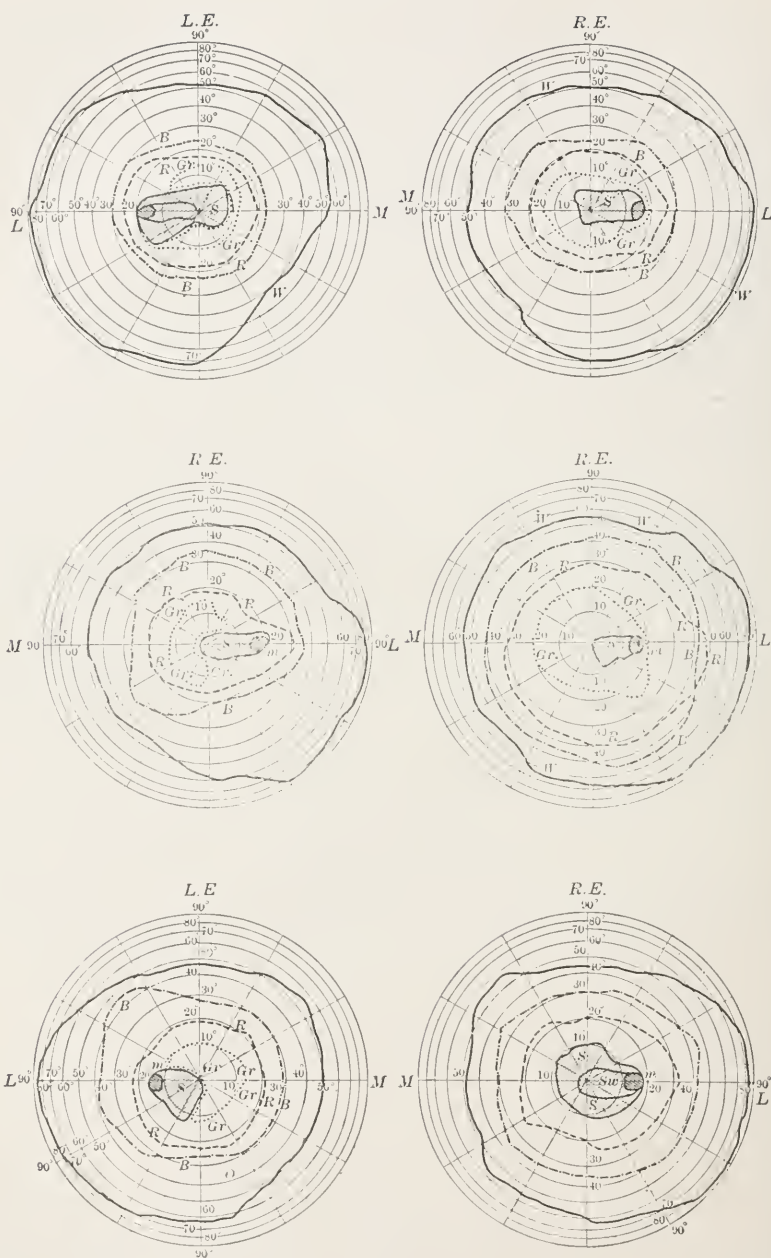
According to Theodorovits, 17 per cent. of the whole amount of nicotin of three-quarters of a cigar is dissipated in smoke, while 5.6 per cent. remains in residue; so that about 0.135 nicotin comes in contact with the mucous membranes in smoking the daily toxic doses. After smoking three-quarters of a cigar the amount of nicotin of the rest is doubled, since a large quantity of nicotin contained in the smoke passing through is retained; consequently the last quarter of the cigar contains half the nicotin of the whole cigar. Thus a person who finishes his cigar to the end introduces twice as much nicotin into his system as the one who smokes only three-quarters of it. This explains the occurrence of tobacco amblyopia in comparatively moderate smokers.

Amblyopia due to tobacco or ethyl alcohol or both combined. Inasmuch as abuse of alcohol and of tobacco has usually been combined in the same individual, most writers have hesitated to ascribe entirely to either of these drugs responsibility for the condition commonly referred to as tobacco-alcohol amblyopia. There is, however, good evidence for the belief that *a very similar form of amblyopia may be caused by the separate use of either alcohol or tobacco.*

The following table by Uhthoff indicates his views as to the comparative frequency of the causes of the amblyopia in his series of cases:

Alcohol	64
Alcohol and tobacco	45
Tobacco	23
Diabetes	3
Lead	1
Bisulphide of carbon	2
<hr/>	
Total	138

But as between the relative importance of alcohol and tobacco, either alone or in combination, there is no unanimity of opinion. There is a widespread belief among eminent authorities that intoxication by the



Various Scotoma for Red and Green in Tobacco Amblyopia. (de Schweinitz, after Hirschberg.)

two drugs simultaneously is much more likely to result in amblyopia than abuse of either one alone.

M. L. Foster (*Archives of Ophthalm.*, July, 1913) reports a case of toxic amblyopia due to tobacco alone. He refers to the doubt which has been expressed whether tobacco alone can produce disease of the papillo-macular bundle of fibers.

The case occurred in a man whose declaration of total abstinence was upheld by careful enquiries made among those who had known him for years, including his family physician. He had been an excessive smoker, and vision was reduced to R. E. 20/70, L. E. 20/200, with a central scotoma for red and such marked pallor of the temporal halves of the discs that they were unhesitatingly entered as atrophied. Treatment by immediate and complete abstinence from tobacco and the administration of strychnin for eleven months, both subcutaneously and by the mouth, resulted in a return of vision to R. E. 20/10, L. E. 20/15, the disappearance of the central scotoma in the R. E. with only a tiny scotoma left in the L. E., and a complete return to normal of the discs.

Foster considers that even one case so definite as this is sufficient to establish the fact that toxic amblyopia can be caused by tobacco alone.

As Parisotti (*Rivista Italiana di Ottalm.*, Nov.-Dec., 1911; abst. *Ophthalmoscope*, Sept., 1914) has shown, it is very rare to find a case of tobacco amblyopia in a person who does not either smoke or use snuff, but the writer has observed a case of this nature. The patient had been engaged in a cigar factory from the age of 15 years. At the time of consultation she was 31; she was healthy, married, with four healthy children; she presented no trace of hereditary trouble. She noticed a failure of vision about four years previously. For the last two or four months she had suffered from pain in the head and constant disturbing scintillations. She saw better in a bad light. Externally there was nothing to note. By the ophthalmoscope Parisotti observed some cloudiness in the right eye, the whole disc and the lower half of the fundus; in the left eye, a similar cloud obscured the infero-temporal sector. In both eyes, the macular region was blurred.

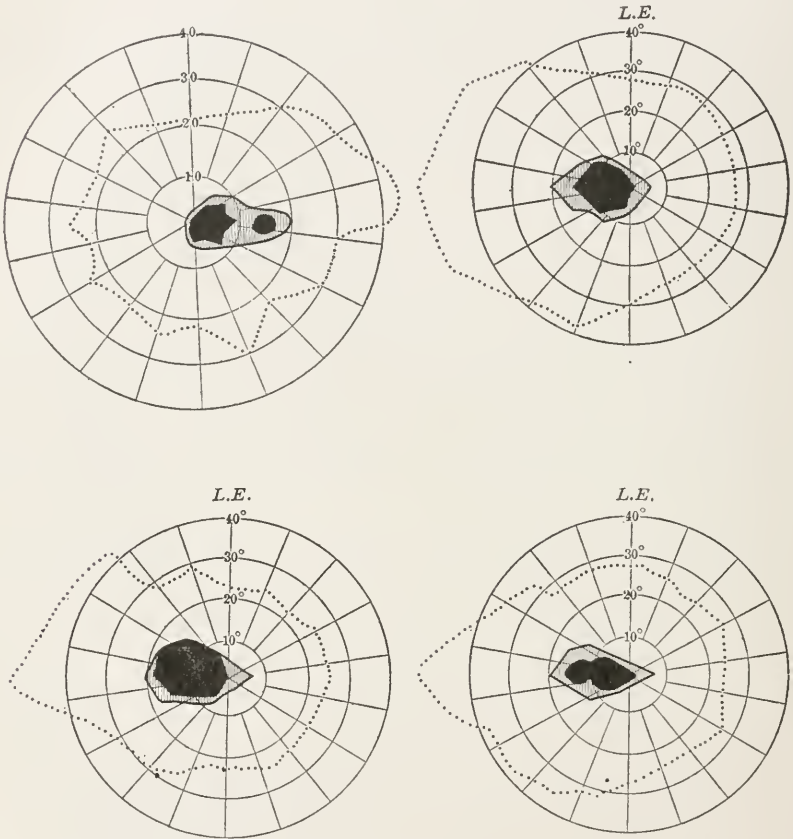
Parisotti was inclined to attribute these changes at first to vasomotor disturbances, of the nature of ophthalmic migraine. There was nothing abnormal in the urine.

Under bromide, the haze disappeared rapidly from the fundus, but there was no corresponding improvement of the visual acuity. Examination of the visual fields showed concentric contraction for white. The fields for red, green, and blue were also contracted, but there was

TOXIC AMBLYOPIA

inversion of the limits; in some places green extended even beyond white. The nervous system was examined and pronounced healthy. There was no sign of hysteria.

Parisotti thinks that even if the alterations of the fields were hys-



Islands of absolute Scotomata within the Relative Scotoma of Tobacco Amblyopia.
(de Schweinitz-Groenouw.)

terical, the changes were probably excited by the intoxication and therefore due to the tobacco.

The *treatment of tobacco and of tobacco-alcohol amblyopia* is practically identical with that of ethyl alcohol blindness.

Danis (*Le Progres Medical*, Jan., 1912) has reported five cases of this condition treated by hypodermic injection into the muscles of the back of an oily solution of 5 per cent. lecithin. Two c.c. were used. During observation tobacco and alcohol were prohibited. Results

were variable. In first case, a betterment about eight days after the start. Improvement, however, continued after cessation of the treatment. The second and third received little benefit. The fourth, which was the worst case, gave the best results, but a decided regression upon discontinuing the lecithin. The fifth patient improved equally well by merely stopping the toxic substances. Danis considered it too early to draw a definite conclusion, because the results were not decisive.

The *Oph. Year-Book* for 1909 has a number of abstracts of literature dealing with this subject, as follows: Among twenty-four cases of toxic amblyopia reported by Stricker, four were attributed to the use of ethyl or grain alcohol, two to chronic tobacco poisoning, and two to alcohol and tobacco. In one of the alcoholic cases, optic neuritis, retinal hemorrhages and ptosis of the right eye were associated symptoms.

Dowling (*Lancet-Clinic*, July 13, 1908) not only records a number of cases of tobacco amblyopia, but also the results of his examinations of the employes in cigar factories and tobacco houses. The negro race seems to be immune, but this statement is not in accordance with the experience of Charles W. Kollock of Charleston, S. C., who is quoted in de Schweinitz's *Toxic Amblyopias* as having seen a number of cases of tobacco, as well as alcohol, amblyopia in full-blooded negroes, and a number of cases of tobacco amblyopia among mulattoes. The prognosis is good if treatment begins early, but usually six to twelve weeks of treatment are required. He considers that the antagonism between nicotin and strychnia is the reason that the latter drug is valuable in the treatment of tobacco amblyopia.

Treutler reports a case of central scotoma, caused by a primary degeneration of the retina in the macula, which had a tendency to enlarge peripherally and which had caused secondary sclerosis of the choroidal blood vessels. The etiological factors were excessive use of tobacco and alcohol. The optic nerves showed no degeneration of the temporal halves. He was unable to find a similar case in literature.

J. T. Carpenter records the case history of a patient with an absolutely sharply-defined central scotoma which remained unchanged for one year. An unusual feature was the persistent, annoying subjective visual disturbance in the blind area of the field, occurring as flashes and scintillating color phenomena of red color. There was some uncertainty in the diagnosis, that is to say, whether the central amblyopia was due to alcohol, tobacco or lead, or to chiasmal disease with central scotoma, or was a representative of tabes or disseminated sclerosis. In the discussion de Schweinitz suggested that the case might be classified

with the so-called stationary optic nerve atrophy with scotoma, especially described by Jansen.

E. M. Blake discusses in general terms many varieties of toxic amblyopia, with especial reference to the effect of tobacco and alcohol upon the vision, and regards, in addition to the removal of the patient from the influence of the drugs, Turkish baths, potassium iodid and strychnia as the remedial agents which will produce the best results.

The *pathology* of tobacco amblyopia (which includes also alcohol and tobacco-alcohol blindness) was first rationally discussed by Samelsohn (*Centralbl. f. Med., Wissenschaft*, p. 418, 1880). See full description under *Alcohol, Ethyl*, in this section.

A. Krueger (*Klin. Monatsbl. für Augenheilk.*, May-June, 1911), finds that in cases of tobacco and alcohol amblyopia, there are pronounced vascular changes of the macular artery and veins, similar to those found in arteriosclerosis. They consist mainly of: 1. Hazy outline of the arterial walls without circumscribed narrowing. 2. Irregular outline with more or less marked contraction of the lumen. 3. Faint haze on the papilla or at the crossing of underlying veins. 4. Occasional breaking of the lumen of the veins by the underlying artery.

In addition there is marked blanching of the left half of the optic nerve and more or less marked change in the macula. The author is strongly inclined to the belief that the primary changes in retrobulbar neuritis are due to disease of the macular arteries, causing disease of the macular fibers of the nerve, showing secondarily in the retrobulbar part of the optic nerve.

P. Chalmers Jameson (*Long Island Med. Jour.*, April, 1919) points out that while the chief constituent of tobacco is, according to Wilcox, 0.5 per cent. of nicotin in the Turkish leaf to a maximum of 11 per cent. in other tobacco, yet this poisonous alkaloid is more or less decomposed in smoking, so that tobacco smoke contains generally a smaller proportion of the poison than the dried leaf but, also, other deleterious agents, such as paradin, picolin, lulidin, collidin, parolin, coridin, rubidin, small quantities of hydrocyanic and acetic acids, creosote, sulphur and carbon compounds.

From a life-long study of the subject Jameson concludes: Tobacco must be regarded as a slow poison if used in any considerable amount and the general opinion that it is always injurious to the young is correct as it is a poison to the young immature cells. There are, however, marked differences in susceptibility [in the adult] and the grown individual should weigh his own idiosyncrasies as a guide to its use.

The existent physical well-being in the early life of a smoker is not always an index to harmlessness, as degenerative symptoms may and do appear after many years of toleration.

Frequent although intermittent vascular stimulation must tend, according to the law of cause and effect, to arterial degeneration, and excess undoubtedly tends to circulatory and nerve degeneration. Probably what is generally regarded as moderate smoking, the equivalent of five or six cigars a day, borders on immoderation from the standpoint of physical well-being and longevity.

Tobacco undoubtedly is an antidote to worry, promotes good-fellowship, renders life more bearable, is one of the least dangerous of the seminareotic group and, above all, does not demoralize.

In many instances the balance of good outweighs the bad influence on body and mind.

To render its use comparatively innocuous and at the same time to derive the joys of peace, calm and solace it undoubtedly bestows, much greater moderation and limitation of its use should be advocated, and if it were made less of a continuous habit and its use confined to times of worry, mental stress and turbulence, and occasional good-fellowship, it would be better for the physical well-being of the world who smoke.

Trinitrotoluene. See **Trinitrotoluene** in this *Encyclopedia*.

Livingston-Learmonth and Cunningham (*Lancet*, p. 261, Feb., 1916) in an article on the effects of trinitrotoluene on women workers, divide the symptoms into two classes, irritative and toxic, and the latter again into digestive, circulatory, cerebral and special. Under cerebral symptoms they say: "Drowsiness is very common and many workers describe it as a sort of drugged feeling. Depression, lassitude and apathy are common. Transient loss of memory, slight disorders of sight (blurred vision, etc.), and a certain amount of transient peripheral neuritis have been noted in several of our cases. In severe cases delirium, coma and convulsions occur toward the end."

As terminal symptoms of trinitrotoluene poisoning, Rice (*Am. Jour. Pub. Health*, July, 1917) mentions delirium, light-headedness and flighty utterances, followed by a stage of coma lasting about twelve hours and ending in death.

Aliee Hamilton (*U. S. Dept. of Labor*, May, 1917) says: "The symptoms that follow inhalation of benzol and toluol fumes or absorption of these are, in mild cases as in severe ones, the symptoms of intoxication by a substance with a special action on the central nervous system: Dizziness, confusion, transient excitement followed quickly by stupor, twitching, then exhaustion, loss of consciousness, with respiration at first rapid then slow, pulse rapid, temperature low.

Delirium, sometimes maniacal, is not rare; tetanic convulsions with marked opisthotonos and high temperature were described in one unusual case. Three cases developed meningitis before death."

Trivalene. See **Trivalene**, in this *Encyclopedia*; also, *Binitrotoluene*, in this section.

Tyrotxin. See *Botulism*, in this section.

Venom of snakes. See *Snake bite* herein.

Veratrum. *Veratrin*. See *Veratrum*; also under *Emetin*, in this section, towards its end.

Wintergreen, Oil of. A form of amblyopia of the salicylate type is (rarely) found after poisonous doses of this drug.

Wood alcohol. See *Alcohol, Methyl*; also *Columbian spirits* herein.

Toxic cataracts. Cloudiness of the lens, due to interference with its nutrition, has been observed to follow doses of *naphthalin*, *ergot*, *beta-naphthol*, *choloral hydrate* and a few other poisons. See p. 1756, Vol. III of this *Encyclopedia*.

Toxicopathy. Any disease induced by a poison.

Toxin. 1. Any poisonous albumin produced by bacterial action. The toxins include: (1) Active protein bodies known as *toxalbumins*, which are produced in the tissues of the body and in cultures by bacterial action. These are amorphous solids with specific poisonous properties, which are destroyed by a temperature of 60° C. (140° F.), and are precipitated by reagents that precipitate albumin. Examples are the toxins of diphtheria, tetanus and botulism. (2) The *intracellular toxins* or toxins that are contained within the bodies of the bacteria themselves. They resemble the toxalbumins in their instability, but differ in that they require a period of incubation after injection before manifesting their activity, while the toxalbumins produce toxic symptoms immediately after their ingestion into animals. Examples are the toxins of typhoid fever, cholera, and the colon bacillus. (3) The *bacterial proteins*, which are much more stable than the first two classes, resisting the temperature of boiling. They seem to have the same properties in all bacteria, not causing specific infection, but all alike causing fever, inflammation, and supuration. Examples are mallein and tuberculin. 4. A poisonous base formed by bacterial action; a ptomain. (*Dorland*.) See, also, **Bacteriology of the eye**.

Toxins, Coley's. See p. 2322, Vol. IV of this *Encyclopedia*.

T. P. An abbreviation for tuberculin precipitation.

T. R. An abbreviation of *tuberculinum recens*.

Trabecula. A septum that extends from the envelope into the in-

closed substance, forming, with other trabeculae, an essential part of the stroma of an organ.

Trabecular fibrinous cataract. Barred cataract.

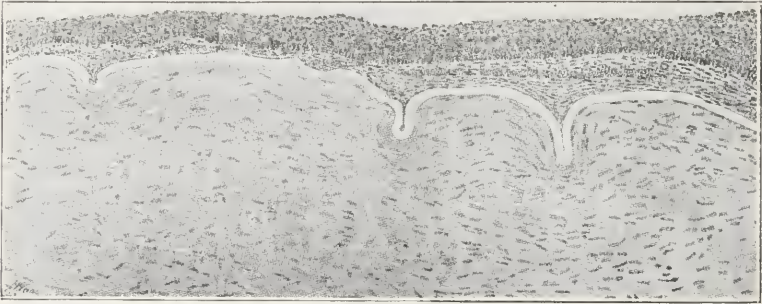
Trachoma. GRANULAR LIDS. CHRONIC OPHTHALMIA or BLENNORRHEA. GRANULAR CONJUNCTIVITIS. EGYPTIAN OPHTHALMIA. "GRANULATED" LIDS. MILITARY OPHTHALMIA. This section should be read with **Conjunctivitis, Granular**, p. 3108, Vol. IV; **Conjunctivitis, Inclusion**; **Bacteriology of trachoma**, p. 834, Vol. I; **Chlamydozoa**, p. 2060, Vol. VII; **Pannus**, p. 9222, Vol. XII; and **Institutions for the blind**, in this *Encyclopedia*.

True trachoma is a world-wide, serious and important ocular infection, generally of long duration, characterized by the presence of *trachoma bodies or granulations*, and ending in cicatricial changes. In addition to hyperemia and discharge, there are numerous grayish or pinkish-red bodies, which are about the size of a pinhead. These are particularly abundant in the conjunctiva of the upper lid and in the upper fornix, but also exist in the lower lid and in the bulbar conjunctiva. Trachomatous tissue may appear on the cornea.

Etiology. The disease originates in infection, but the cause is unknown. It has been attributed to a small, double coccus (trachoma-coccus) by Sattler and von Michel; to parasitic protozoa by Pfeiffer and Ridley; and to a fungus, *Microsporon trachomatosum*, by Muter-milch. In 1907 Halberstaedter and von Prowazek described, in the epithelial cells of the conjunctiva in trachoma cases, inclusions (trachoma bodies) which they believed to be parasites and the cause of trachoma. The more recent investigations show that the trachoma bodies are not specific for trachoma (McKee).

The disease is spread by transfer of secretion from a trachomatous eye, the virulence of the process depending upon the quantity and quality of the discharge. The most dangerous epidemics are those characterized by an abundance of yellowish discharge. A trachoma which is kept in check by systematic treatment possesses slight power of contagion. The disease is common in places where many persons are crowded into small quarters and where unhygienic conditions exist, as in barracks, workhouses, orphan asylums, and schools. The agents concerned in passing infectious particles are numerous, and include such media as washing utensils, hands, handkerchiefs, bedlinen, medicine-droppers, etc. In foreign climes, where the heat is great, flies are the chief factors in spreading the contagion. Not age, but race, is an etiologic factor. Thus, trachoma is common among Hebrews, Italians, Egyptians, and other inhabitants of the East. The negro is almost exempt. The disease is common in Ireland. The geographic

distribution of trachoma is interesting. It is frequent in Arabia, Egypt, the eastern part of Europe, and the lowlands. Elevated areas, such as the Tyrol, Switzerland, and isolated mountain districts, where the altitude exceeds 6000 feet, are practically exempt. It is also of rare occurrence in Scandinavia and in southern California. The disease is common in the western prairie districts of the United States, particularly in regions where sandstorms are frequent. Ziem states that the prevalence of the disease has kept pace with the destruction of forests and the consequent production of dust and sandstorms. It is supposed by Kuhn that nasal disease is an etiologic factor. It has been erroneously believed that trachoma was first introduced into Europe by Napoleon's soldiers returning from Egypt in 1798. It is probable that eye-strain, by causing conjunctival hyperemia, predisposes to the development of trachoma. The ques-



Cicatricial Pannus, Showing Several Follicles. (Baas.)

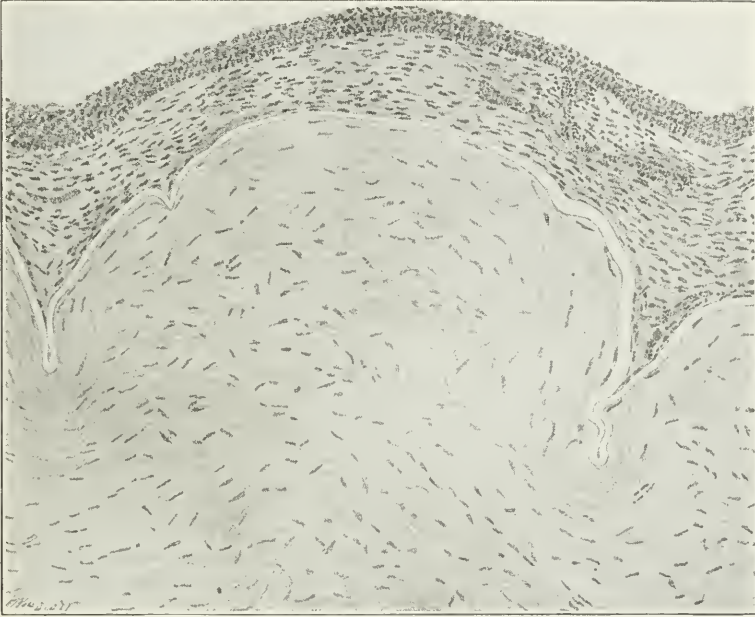
tion whether malaria influences it is unsettled. Persons of the so-called scrofulous (tuberculous) temperament are prone to the disease.

Forms of trachoma. The subject of trachoma may fitly be considered under the following subdivisions: 1. Papillary trachoma. 2. Granular or chronic trachoma. 3. Mixed trachoma.

1. The term *papillary trachoma* (papillary granulation or hypertrophy) means that the papillæ of the upper lid, more rarely of the lower, are enlarged and recognizable by the unaided eye. In mild cases the conjunctiva resembles sandpaper, while in severe ones it has been compared to the pile of velvet. It looks moist, red, and velvety. Early in the case lachrymation is profuse. Later a muco-purulent or purulent discharge appears. The conjunctiva is injected, the papillæ are enlarged, and the characteristic granulations are scattered through the membrane. After a variable period the disease subsides. In favorable cases a cure results, the granulations being absorbed and a smooth conjunctiva remaining. In other patients there are indica-

tions of scar-tissue in the mucous membrane, or the disease may pass into the chronic form.

2. Granular or *chronic trachoma* generally is chronic from the beginning, but in some cases it results from the imperfect disappearance of the papillary form. The characteristic feature is the presence of the trachoma granules. These are round, opaque bodies, of grayish-white color, measuring about two millimetres in diameter. They are deeply set in the conjunctiva and are often confluent, thus forming



Cicatricial Pannus, Showing Single (Enlarged) Follicle. (Baas.)

areas of trachomatous material. They may be scattered over the whole conjunctiva, but are particularly numerous where the adenoid tissue is abundant: i. e., in the fornices, especially the upper one. The conjunctiva may be hyperemic or anemic. There is generally a slight muco-purulent discharge. The eyes burn and smart, near work becoming difficult, particularly at night. The disease may continue thus insidiously for many months, when suddenly an attack of acute inflammation ensues and the picture changes to that of acute inflammatory trachoma. Redness, pain, lachrymation, photophobia, discharge, blepharospasm, corneal inflammation and ulceration, and rapid loss of vision are now important symptoms. Acute inflammatory trachoma is simply trachoma to which an acute conjunctivitis has been added.

When, in the quiet form, the lids are everted, the characteristic granulations appear as sago-like elevations which are arranged in rows and are particularly prominent in the fornices. A few isolated trachoma bodies may be seen in the bulbar conjunctiva. The membrane is rough, and does not show the velvety appearance found in the papillary variety. After the advent of inflammatory symptoms the membrane shows swelling of the papillæ, which may obscure the granulations. They may be absorbed, but generally new trachoma bodies appear, and thus the disease continues indefinitely. After a variable period grayish-white bands of connective tissue are to be seen, marking the appearance of the stage of cicatrization. Thus the disease improves at the expense of the normal conjunctiva, which is replaced by scar-tissue. In this stage the tarsal plates become deformed, producing trichiasis, entropion, and corneal ulceration. The conjunctiva is converted into a pale, bluish-white, atrophic membrane, and the fornices are much reduced in size or are entirely obliterated.

3. *Mixed trachoma* is a common condition, the papillary and granular forms being present simultaneously. The papillary form involves chiefly the tarsal conjunctiva, while the granules develop luxuriantly in the fornices.

Sequelæ and complications of trachoma. The chief complications of trachoma are corneal ulcers and pannus. Corneal ulcers may appear at a place where the cornea is normal or in connection with pannus. The nature of these ulcerations does not demand special attention in this place. Pannus (see the figures) consists in the formation of a new growth of connective tissue which is situated between the epithelium and Bowman's membrane and is provided with blood-vessels. This new tissue presses its way from the periphery toward the centre, and corresponds chiefly to that part of the cornea in relationship with the upper lid. Pannus may disappear entirely, or the enlarged vessels may shrink, leaving small, radiating lines to mark the spot where they existed. If ulceration is associated with pannus, the cornea will likely remain clouded in its upper part. Buller has seen cases of trachoma associated with ichthyosis.

Among the sequelæ are trichiasis and entropion. Normally the margin of the lid, at the point where the conjunctiva and skin unite, forms a right angle. In trachoma it is worn away, and the eyelashes, being given a wrong direction (trichiasis), rub on the cornea, producing constant irritation. The contraction of the newly-formed connective tissue leads to thickening and incurvation of the tarsal plate (see **Entropion**, p. 4331, Vol. VI) with trichiasis. Continuance of either condition leads to corneal inflammation and ulceration. The lower

eyelid often turns outward as a result of trachoma. The thickened conjunctiva presses the lid-margin away from the globe and contraction of fibres of the orbicularis muscle completes the eversion (spastic ectropion). When atrophy of the conjunctiva has become marked, the folds in the fornices disappear and the mucous lining of the lids passes directly into that of the globe (posterior symblepharon). In excessive atrophy the conjunctiva is converted into a dry, tough membrane (xerosis); the cornea suffers at the same time, becoming cicatricial and opaque. In the course of trachoma in the Malay race, and also among the Chinese, Steiner observed pigmentation of the conjunctiva in the form of irregular dots and lines. The spots, which are found most frequently on the upper lid, are black. They are without pathologic significance. Among the most important sequelæ are the corneal changes, which include: (1) the formation of scars, following ulceration, by the transformation of pannus into connective tissue; and (2) the alterations in curvature, which may be slight or may produce a decided bulging of the membrane (ectasia of the cornea). Thus it is seen that trachoma, by reason of its complications and sequelæ, is one of the most important of ocular diseases.

Pathology of trachoma. As regards the nature and origin of the changes found in trachoma there is much dispute. Iwanoff, Berlin, and others contend that there is a new product, while Sattler, Raehlmann, and Vincentis believe that there is simply a change in the normal tissue. Burnett states that the process is probably a combination of both. Attempts which have been made to distinguish histologically between follicular conjunctivitis and trachoma have not been successful. Herbert believes that the difference is in the amount of material present in the two types. He states that in follicular conjunctivitis and trachoma, in addition to an increase in the number of large plasma-cells (rounded cells modified from connective-tissue cells in chronic inflammation) which are distributed through the conjunctiva, there is an hypertrophy of existing follicles and lymphoid tissue, with a new formation of these structures. The changes in trachoma begin in the lymphatic spaces of the lymph-vessels. Such a collection of cells, encapsuled by vessel-walls, by growth gives origin to a follicle. Commonly the follicles are formed by the continued addition of cells grouped in lymph-spaces and lymph-vessels. Absorption of follicles, according to the same authority, takes places in various ways: 1. The cells are carried away in the lymphatics. 2. Other cells become amoeboid and travel through the surface epithelium or into the blood-vessels. 3. Others undergo vacuolar or hyalin degeneration. The trachomatous process involves all parts of the conjunctiva, except the ocular portion near the cornea and a narrow strip, three millimetres

broad, next to the lid-borders. These parts normally are covered by stratified squamous epithelium. As regards the hypertrophic changes, there is an extension of surface by the formation of papillæ and an increase of epithelium in epithelial downgrowths. These epithelial tubules often lead to the formation of cysts possessing yellowish and cheesy contents. In the stage of atrophy there is a disappearance of areas of the normal fibrous and elastic matrix of the conjunctiva, with the formation of scar-tissue. The development of papillæ is not characteristic of trachoma, since they may attend any type of conjunctivitis of considerable duration.

The *diagnosis of trachoma* generally presents little difficulty. Such diseases as chronic catarrhal conjunctivitis, vernal catarrh, and the papilliform swellings of purulent conjunctivitis will not embarrass the careful observer. Between the false, or follicular, granulation and the true, or "sago-grain," granulation differentiation may sometimes be difficult. The chief characteristics of these affections, which are different clinically, but not histologically, are given by Stephenson as follows:—

DIFFERENTIAL DIAGNOSIS OF TRACHOMA.

- | Follicular, or false, granulations. | "Sago-grain," or true, granulations. |
|---|---|
| 1. Oval or roundish, transparent bodies, the diameter of which seldom or never exceeds 1 or 1.5 millimetres. They often possess a faint-yellowish hue, and are usually arranged in rows. Their tendency is to remain discrete; that is, separate from one another. They are always larger in the inferior fornix. | 1. Round, opaque, ill-defined bodies of grayish-white color and extreme friability. Firmly and deeply imbedded in the conjunctiva, their diameter often reaching 2 millimetres or more. They tend to become confluent, thus forming areas of trachomatous material. They are always larger and more numerous in the upper fornix. |
| 2. Seldom are associated with much change in the structure of the conjunctiva. | 2. Structural changes are always present in the conjunctiva. |
| 3. Papillary hypertrophy of the upper lid is trivial. | 3. Papillary hypertrophy of the upper lid is marked in many of the cases. |
| 4. The tarsus is not implicated. | 4. The tarsus is often involved. |
| 5. The growths disappear spontaneously without forming scar-tissue. | 5. Spontaneous cure occurs only with the onset of scarring, which may be slight or extensive according to the degree of development of the original granulations. |
| 6. No drooping of the upper lid. | 6. Upper lid droops in most cases. |
| 7. Pannus and corneal ulcers are absent. | 7. Pannus and corneal ulcers occur in at least 25 per cent. of the cases. |
| 8. Trichiasis, entropion, and shrinking of the cul-de-sac do not occur. | 8. Trichiasis, entropion, and shrinking of the cul-de-sac occur very frequently. |
| 9. Occurs chiefly in persons under twenty years of age. | 9. May occur at any age. |
| 10. Not contagious. | 10. Conditionally contagious. |

When seen early and treated persistently the *prognosis of trachoma* is favorable. Corneal ulceration and pannus often give better results than would be expected, although vision is often reduced. Trichiasis and entropion can be relieved by operative treatment. In the stage of atrophy treatment is of little use. Unfortunately persons with trachoma often cease treatment too soon, and under such circumstances they are sure to suffer a recurrence. Such cases often end in blindness or in serious reduction of vision. A trachomatous eye is always liable to attacks of acute inflammation in response to a fresh irruption of trachoma follicles or to external irritants.

The *treatment of trachoma* is prophylactic, medical, and surgical. When possible these cases should be isolated. In private practice each patient should have his own towels, soap, washbowl, and handkerchiefs. In asylums and schools the lavatory arrangement should include what is known as the "jet system," which makes it impossible for the same water to be used by more than one person. Cleanliness is always in order in trachoma. Hot water and Castile soap are probably as efficient as any of the numerous antiseptic washes.

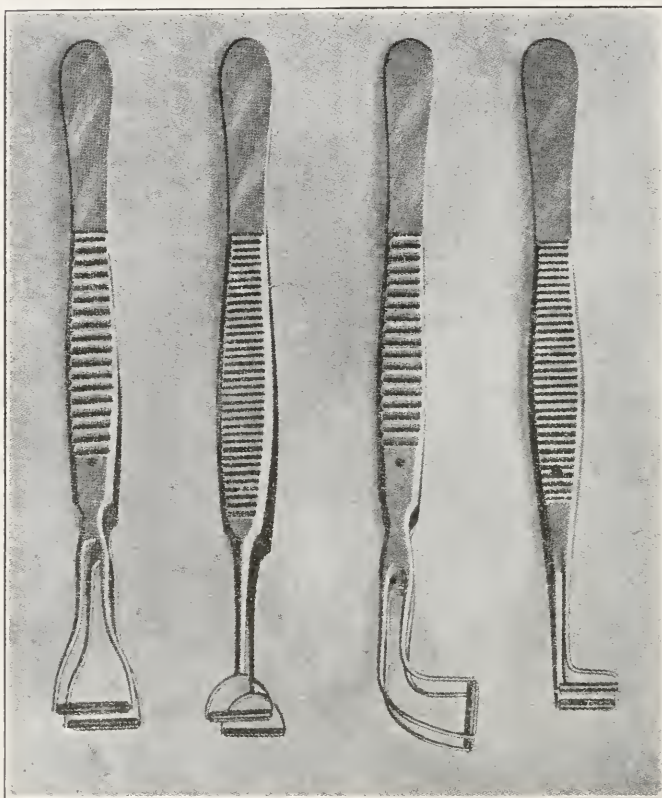
The *medical treatment* may be formulated as follows: In acute inflammatory attacks cleanliness, hygienic measures, and atropin are to be employed until the pain and inflammation have subsided. Then once daily the conjunctiva of the lids and fornices is to be painted with a solution of nitrate of silver, of the strength of 2 or 3 grains to the ounce, until the secretion ceases. If the cornea is involved atropin is to be used once or twice a day. This treatment should be continued week after week, but it must not be kept up indefinitely, because of the danger of producing argyrosis. In applying the silver solution the surgeon should see that it reaches the folds in the upper fornix. Caustics are absolutely to be eschewed in this as in every other form of conjunctivitis. What is wanted is stimulation of the absorbents, not destruction of the membrane. In many lands, after the secretion has diminished, a stick of lunar caustic or copper sulphate is employed. Schiele uses the solid stick of iodic acid, and claims that it does not cause a scar. Nesnamoff employs a 1- or 2-per-cent. strength solution of iodine in liquid petrolatum. Seabrook commends this treatment in chronic cases with little secretion. Ichthyol in 10- or 20-per-cent. strength solutions has found favor with some ophthalmic surgeons. In the hands of many practitioners copper and other caustics are positively harmful. When used they are to be employed simply as irritants, not as escharotics, and their application will not be in order until after the discharge has practically ceased. Instead of copper, a stick of alum can be used as a stimulating agent. It is possible, as Thompson

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has remarked, that trachoma is a very different disease in the Mississippi Valley from that type found in some far-distant place, and that the treatment should vary accordingly. As the case improves under



Falta's Trachoma Curette.

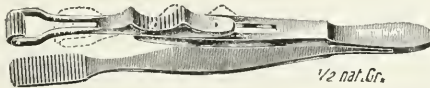


Trachoma Forceps. (1) Rust's, (2) Wills Eye Hospital, (3) Knapp's, (4) Knapp's Angular Forceps.

the treatment outlined, the period between the applications may be lengthened and the patient can make use of a collyrium of sulphate of zinc, boric acid, protargol, or argyrol. The use of a 3- to 10-per-cent. strength ointment of citrate of copper in white vaselin is recommended

by Wright, of Mobile. He states that it produces absorption of the granulations, is non-irritant, and can be used by the patient.

Under medical treatment improvement of trachoma is often a slow process. Hence *various surgical measures* have been advocated, and many of these are of great antiquity. Among those worthy of mention are scarification, curettage, expression, brossage, grattage, excision of individual granulations, excision of the cul-de-sac, [excision of the tarsus] the application of the galvanocautery and electrolysis, or the use of the X-rays, [all of which are discussed and described under their appropriate headings in this *Encyclopedia*]. These measures, as a rule, are to be employed only in cases in which acute symptoms are absent and which resist medical treatment, although some eminent authorities prefer them to medical measures. The objection to



Schnaudigel's Trachoma Forceps.



Knife with Guard for Tarsal Subsection in Inveterate Trachoma. (Ewing.)

most surgical procedures is that the scar resulting from the operation may more than offset the good derived from the operation. Of the surgical procedures, the least objectionable is expression. This can be done in various ways, but the use of the roller forceps is preferred. See the illustrations in this section, as well as under **Forceps**, p. 5245, Vol. VIII of this *Encyclopedia*. The instrument is used to express the contents of the trachoma follicles, and this is accomplished rapidly and safely under local or general anesthesia. Expression may be used alone or it may be combined with scarification of the conjunctiva and the local use of a germicide which is rubbed into the tissue by means of a stiff brush. The author prefers expression used alone and followed immediately by cold compresses. Later for several weeks a solution of nitrate of silver is to be applied. In using expression care must be taken to press out the trachomatous material in the region of the fornices and canthi. Stephenson, Walsh, and Mayou have reported favorably on the treatment of trachoma by X-ray exposure.

Radium has been used by Selenowski and others with good results. A tube containing 10 milligrams of radium bromid is placed against the everted lid for a period of from two to ten minutes; the treatment is continued at intervals of a few days.

Pannus generally clears up *pari passu* with the improvement in the conjunctiva, but in some cases, in which there is a formation of dense connective tissue, it may require special treatment, such as the use of jequirity or the performance of periectomy. *Jequirity* (see p. 6721, Vol. IX of this *Encyclopedia*) which was introduced into ophthalmic practice by de Wecker, is employed to set up a violent corneal inflammation in the hope that with its subsidence the pannus will disappear. It is used in an infusion (3 to 5 per cent.) applied to the everted lids, or the powdered drug may be dusted on to the conjunctiva. The latter method is highly recommended by Cheatham. The jequirity treatment must be used with caution, since some cases have been reported in which its employment was followed by destruction of the cornea. In many cases it has a curative effect on pannus. Landolt and Holmes favor the treatment of pannus by boric acid and massage.

Since pannus is a corneal complication of a circumcorneal disease, the excision of a piece of conjunctiva adjacent to the cornea has been done for the purpose of producing an area of cicatricial tissue, which shall act as a safeguard against invasion. Boeckmann, who has had an extensive experience with this operation (peridectomy), regards it as a harmless and efficient treatment for pannus.—(J. M. B.)

In addition to the foregoing, some abstracts from the voluminous literature of the subject may be of value. These are presented as much as possible under collective sub-heads and in chronological order.

Prevalence and Prevention of Trachoma.

Trachoma in Egypt. The Near and the Far East are particularly the homes of trachoma. In Egypt, Syria and India, and other oriental countries, it takes on the guise of a national scourge. Under **Institutions for the blind**, p. 6404, will be found a detailed and illustrated account of the prevalence and care of the persons afflicted with the disease in Egypt.

Mohamed Eloui Pascha, discussing the occurrence of trachoma before the First Egyptian Medical Congress (December, 1902; official record, 1907), stated that trachoma had greatly lessened in Egypt during the previous twenty years; in the schools, for example, from 85 to 57 per cent. Among 11,660 patients, 17 per cent. had trichiasis, 10 per cent. various forms of keratitis, 6 per cent. pannus, and 7 per

cent. glaucoma. The frequency of trachoma in Egypt is partly due to the defective culture of the populace and also to climatic factors.

C. P. Franklin (*Bull. Am. Acad. Med.*, June, 1913) after inspecting the quarantine work performed by U. S. national, state and municipal authorities, concludes that, owing to the work of the Public Health and Marine Hospital Service at our ports of entry, as well as that of the various state quarantine services, further fear of the contagion from trachoma from aliens coming into the United States, has been unfounded since 1907. The danger to America from trachoma comes from neglect of the contagion from aliens suffering from trachoma admitted prior to the passage of the law of 1907.

The *Ophthalmic Year-Book* for 1913 reports that Cuénod found 50 per cent. of the eye patients in Tunis were trachomatous. Mixed infections and xerosis trachomatosa were frequent. He states that the virus of trachoma is filterable and is present in the tears. Minici states that the incidence of trachoma in Italy was trebled between 1874 and 1889 and that it doubled again between 1889 and 1908. McMullen states that of 1,167 cases of trachoma certified to at Ellis Island, N. Y., in the year 1911, nearly 60 per cent. came from Russia and Italy (South), both countries furnishing about the same amount; about 16 per cent. from Austria-Hungary, about 13 per cent. from Turkey and the remainder from Greece and various other countries. Stucky gives his experience with trachoma as found among the natives of the mountains of eastern Kentucky. The disease had been chronic, sometimes with months or years between the time of its incipency and terminal stage of cicatrization, with one or several of the inevitable sequelæ. Never did he see a case which could with confidence be diagnosed as acute trachomatous infection, and the many instances in which but one eye was found involved led him to the conclusion that there must be some condition of the conjunctiva in the eye or in both eyes of some that creates an immunity to the disease. (For this writer's account of his most interesting and valuable work see the *Journ. Am. Med. Assocn.*, p. 1116, Sept. 27, 1913.) Harrison states that in several years of government service he has never found but one band of American Indians, numbering 346, wholly free from trachoma. These are a fragment of the great Chippewa tribe scattered along the north coast of Lake Superior from Detroit to Port Arthur, a distance of more than 200 miles. Among visiting Canadian Indians in the United States he has found an unusually large percentage afflicted with trachoma.

J. W. Schereschewsky (*Journ. Am. Med. Assocn.*, p. 1113, Sept. 27, 1913) of the United States Public Health Service, reports that thirty-

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nine thousand Indians in the United States were examined with the result of finding that over 17 per cent. were suffering with trachoma. The incidence of the disease varied from over 70 per cent. of the Indians examined in Oklahoma to 0.2 per cent. of the Indians of New York State. The disease was found to be most prevalent among the inmates of Indian boarding-schools, and least prevalent among reservation Indians. All grades of the infection were seen.

Its prevalence among Indians is due to their ignorance of hygiene and sanitation. The percentage of Indians suffering from visual defects due to trachoma is high, and the Indians are likely to prove a means for the wide-spread dissemination of trachoma in the West.

This writer says that energetic efforts should be directed toward limiting the spread of trachoma among the Indians and attempting its eradication among the younger generation.

The accompanying table shows the number of Indians examined in each state, the number of cases of trachoma found, and the percentage of incidence.

TABLE SHOWING PREVALENCE OF TRACHOMA AMONG INDIANS IN DIFFERENT PARTS OF COUNTRY (REPORTED IN 1913) :

State	Indians Examined No.	Cases of Trachoma	Per cent.
Arizona	5,873	1,459	24.9
California	1,555	238	15.3
Colorado	292	41	15.64
Florida	22	....	....
Idaho	526	84	15.96
Iowa	53	17	32.04
Kansas	834	176	21.1
Michigan	643	48	7.46
Minnesota	3,542	533	15.05
Montana	2,042	537	26.3
Nebraska	322	130	41
Nevada	851	229	26.9
New Mexico	2,207	494	22.38
New York	943	2	0.2
North Carolina	317	23	7
North Dakota	3,447	791	22.94
Oklahoma	3,252	2,235	68.72
Oregon	904	94	10.4
Pennsylvania	552	76	13.76

State	Indians Examined No.	Cases of Trachoma	Per cent.
South Dakota	6,121	1,059	17.24
Utah	182	75	39
Virginia	43	13	30.2
Washington	1,347	180	13.85
Wisconsin	2,999	207	6.86
Wyoming	392	199	51
	<hr/> 39,231	<hr/> 8,940	<hr/> 22.7

Borbély reported 1,063 cases of trachoma in the Austro-Hungarian Army in 1905, the number constituting 12 per cent. of all cases of eye diseases which were treated.

As the result of prolonged statistical studies, Boezkowsky comes to the conclusion that 25 per cent. of all cases of incurable blindness in Russia are due to trachoma. Women become blind more frequently than men, and foreigners more often than the native Russians. Blindness from trachoma also occurs in children.

D. W. and Chas. E. White (*Ophth. Record*, May, 1912; abstract in *Ophthalmology*, p. 610, July, 1913) submit their personal experience amongst over 100,000 Indians of the United States. A conservative estimate of the number of known cases of trachoma amongst the Indians of Oklahoma could safely be placed at 60,000 to 70,000, or about 60 to 70 per cent. of the entire population (Indian) of the state. It can also be safely estimated that from 60 to 80 per cent. of the population (Indian) of the United States have trachoma. The trachoma bodies of Prowazek are considered by the writers as one of the most useful aids in diagnosis. The medicinal treatment is of doubtful value to the patient.

The writers' operative procedure in cases where they found hypertrophy with superficial follicles was to use sandpaper alone. In hypertrophy with deep follicular formation sandpaper and forceps are employed. In marked hypertrophy either sandpaper or the light application of Knapp's forceps showed excellent results. In cases showing superficial follicular formation not accompanied by hypertrophy, sandpaper proves of great value. The forceps have not proved beneficial in cases of hard follicular formation, and in these instances sandpaper has proven its efficiency. In cases where the lids are rough and granular, just beginning the cicatricial stage, sandpaper and the Kuhnt forceps or rasp has been employed with good results.

White's silica trachoma rasps (sand or orange wood sticks) are made in five different shapes and angles, so that every portion of the eyelid can be reached. They are used only once and then discarded, thus preventing the danger of reinfection.

The authors still have another operation—the palpebral conjunctiva without the tarsus can be removed, or vice versa, but if they want to eliminate the trachomatous tissue, both are removed.

J. W. Kerr, in *Public Health Reports*, August 20, 1915, gives a history of the fight against trachoma in the United States. Investigations inaugurated in 1897 in the immigration service led to the declaration by the surgeon-general that trachoma was a "dangerous contagious" disease, and since then all arriving aliens have been carefully examined for trachoma with a view to the exclusion of those infected. During that period, 11,966,897 immigrants were examined, and 22,984 trachoma cases were found. Official and nonofficial inspections and examinations abroad and at home reduced the number of cases in immigrants from 4 per cent. prior to 1897 to 2 per cent. Canada followed the example of the United States, and also instituted an inspection service. Within the last few years, many cases of trachoma have been found in the United States not originating in the immigration service. Investigations along this line by McMullen and others of the Public Health Service in the Appalachian Mountains, in Kentucky, West Virginia, Virginia and the Carolinas, showed many trachoma cases among the inhabitants, and also among the Indians on various Indian reservations, in Oklahoma, Minnesota and other states. Among 192,788 white and colored persons examined to April 30, 1915, there were found 3,619 cases of trachoma, and among the 39,231 Indians examined to Dec. 30, 1912, 8,940 cases.

Among the requirements set forth by Kerr for the improvement of trachoma conditions are the elimination of foci of the disease, and the improvement of community sanitation. It is said that trachoma is largely a disease of insanitary surroundings, and their abolishment will depend in a great measure on improving the social and economic conditions in infected communities. In bringing about these improvements, the education of children in individual prophylaxis is essential. Treatment is individual and surgical, and must be begun in a hospital. In the way of prophylaxis in the Appalachian Mountain region, five hospitals have been established, three in Kentucky, one in Virginia and another in West Virginia. In the three hospitals in Kentucky, available to the people in 10,000 square miles of territory, to May 1, 1915, 1,437 cases of trachoma had been treated, with a total of 18,860 treatments, and 1,823 operations performed. A fair propor-

tion of the cases have been already cured, it is said, and over a thousand foci of infection eradicated. Educational bulletins regarding the prevention of trachoma have been sent to over 12,000 households, 120 public health lectures have been given, and visits for purposes of instruction were made to 677 homes. The work of eradication is expected to take years, but eventually it will yield to scientific treatment, and the benefit of the instruction, in the prevention of other diseases, will be great.

Tieo (*Zeitsch. f. Augenh.*, Nov., 1914) reports on the prevalence of trachoma in the schools of Jerusalem. He treated 4,525 cases and found only nine cases of pannus. The disease is endemic in Jerusalem and found in early youth, even in infants. The higher classes presented the most cases, but fresh infections occurred most frequently in the younger classes, while the cicatrizing cases predominated in the higher. About thirty per cent. of the Jewish population have trachoma, while eighty per cent. has been computed among the Arabian.

Frank Allport (*Oph. Year-Book*, 1916) from a study of the laws regulating the care of trachoma in the United States claims that the disease is a real menace to this country. Notwithstanding this no trachoma laws whatsoever exist in fifteen states or in the District of Columbia. In all of the other states except Kentucky, Washington, Montana, Massachusetts and Indiana, the law takes further cognizance by having individual trachoma laws. No law other than the declaration of trachoma as a contagious and reportable disease exists. Kentucky not only requires the prompt reporting of trachoma by doctors, etc., under penalty of a fine, but explains to the public in proclamation the seriousness of the disease physically, sociologically and financially. It excludes from all schools trachomatous children and offers suggestions as to the general care of the disease. It arranges for an Annual State Board of Health School for the purpose of giving instruction to health officers. This work has been accomplished through the exertions of Stucky, McCormack and Linda Neville.

Arthur S. Tenner (*Journ. Am. Med. Assocn.*, p. 227, July 21, 1917) makes a plea for the acceptance and retention of trachomatous conscripts in the United States Army. He says that to exclude victims of trachoma from the ranks is no doubt desirable, but in so doing, first, the army will lose many men who in a short time (from three to six months) could be cured of trachoma and be made safe as far as contagion is concerned. Secondly, these excluded persons return to their homes, continue to live under unhygienic conditions, and cannot be kept under supervision. The fact must also be borne in mind that

many of these persons are employed in factories where they disseminate trachoma among their fellow workers. In this connection, it may be interesting to recall two facts, first, that trachoma was introduced into Europe on a large scale by the soldiery, namely, the French and English soldiers returning from Egypt after the Napoleonic expedition, 1798-1801, and second, that it was disseminated among the civilian population by the discharged soldiers affected with eye diseases. At one time there were so many trachomatous soldiers in the Belgian army that the government applied to Jungken, a celebrated ophthalmologist in Berlin, for advice. He recommended that they dismiss the trachomatous soldiers to their homes. By means of this ill-advised measure trachoma soon became diffused in Belgium to an extent that has been observed in no other European state.

There is, of course, no danger of such an error being made today, but at least one European country engaged in the present war—Austria—decided some time ago that the exclusion of men of military age afflicted with trachoma was inadvisable from the standpoint of helping the individuals excluded, and unnecessary from the standpoint of military prophylaxis. It was found impossible to keep such excluded men under supervision and treatment; accordingly the authorities in Austria refused to accept trachoma as excluding the patient from military service, and also placed all trachomatous patients liable to military service in military institutions under the care of special physicians, until they were completely cured, after which they were sent for military service or were dismissed, according to the age at which the cure was effected. The average length of treatment was four months, and about 80 per cent. of the patients were cured within the period of liability to military service. During the service age, the trachoma patients were given regular military training at the garrison hospital.

Lieut.-Col. Geo. S. Derby (*Pre. Sess. Reprint. Sec. Oph., Am. Med. Assocn.*, June, 1919) reports from Eason's article (1918) that on the invalid list of the British army during 1918 were more than 5,000 soldiers rendered blind by trachoma. From 1813 to 1817, from 20,000 to 30,000 men of the Prussian army were affected. From 1816 to 1839, over 76,000 men in the Russian army were trachomatous.

A comparatively small number of cases of trachoma was found among our soldiers in France, and the proposal was made by the senior ophthalmic consultant to the chief surgeon's office that all such cases be segregated in a hospital area where they could have proper treatment and could be used as labor. On the ground that there were not enough of them to make this procedure worth while, this suggestion

was not acted on, and they were held for treatment in the various hospitals.

Symptoms and complications of trachoma. The *Ophthalmic Year-Book* calls attention to the article by Calderaro on a form of opacity arising in the course of trachoma, that may readily be confused with calcareous change or opacity due to lead. A prominent yellowish-gray plaque, made up of the union of many smaller plaques, develops in the cornea. The conjunctival vessels cross the 1.5 or 2 mm. of relatively clear peripheral cornea, and arriving at the plaque break up into minute branches. The appearance is produced largely by cells surrounding the minute branches of the new formed vessels. He has not found a calcareous degeneration present in such opacities. Corneal symblepharon following trachoma has been observed by Sameh Bey in twenty-three cases out of nearly 350,000 cases of eye diseases. They may arise without any very active treatment of the trachoma.

The clinical characteristics of the trachoma epidemic at Köln were, according to Stiel, a chronic hyperplastic inflammation of the palpebral conjunctiva, with new-vessel formation, lymph, leukocytes, plasma cells, giant cells and so-called Leber inclusion cells. The latter he considers to be blastomycetes, unusual cells which stain like yeast cells. They are present in trachoma in large numbers and are probably the exciters of the inflammation. Inoculation tests, human and simian, failed to excite a specific inflammation. The presence of blastomycetes in trachoma tissue, which he considers demonstrated beyond doubt, may produce the clinical picture of trachoma notwithstanding the absence of conveyance, or it has no significance in the production of granular conjunctivitis and is purely accidental. Von Arlt records the recurrence of trachoma in an eye which had been apparently cured for 19 years. The primary attack was treated for 3 years. But one eye was affected. Meyerhoff reports an instance of trachoma infection of the sound eye of a man who had had trachoma in the fellow eye for 31½ years. It followed five days after the operation of Heisrath-Kuhnt and the Knapp roller operation on the first affected eye. Kubli does not consider that trachomatous subjects are greatly to be feared in day schools if not too numerous and if carefully watched, but it is quite otherwise for boarding institutions. He believes that the exciting agent is to be found in the earth, manure and sand. Knapp has found trachoma granules in the cornea, beneath the vessels of an old pannus. It was a direct extension of the trachomatous process along the scleral conjunctiva. The patient had excision done five years previously. Pick has seen an instance of pigmentation in tra-

choma. The case was one in the cicatricial stage. The spot was sub-conjunctival and uniformly black.

MacCallan's stages of trachoma. This writer (*Ophthalmic Record*, Dec., 1910) has amplified his well-known clinical classification of trachoma. He believes that a division of the disease, at any rate as it exhibits itself in Egypt, into four stages greatly facilitates our conception of its clinical course and of the treatment which is indicated. The classification depends upon the comparative prominence of the three features, granulations, papillary hypertrophy and connective tissue formation.

Trachoma, he says, is a condition of the mucous membrane of the eyelids, in which gross changes occur, resulting in the formation of so-called granulations (with or without a papillary hypertrophy), which in favorable cases disappear and are replaced by connective tissue. Trachoma I is the beginning of the disease, and Trachoma IV is its end, when a cure has resulted (either naturally or by treatment).

Trachoma I is well described by Hourmouziades: "One finds on the conjunctiva of the tarsus and of the superior cul-de-sac, especially at the two extremities of the tarsus, slight roughness, forming grayish or grayish-yellow islands which are semi-transparent and almost avascular, with small bloodvessels converging towards them. These roughnesses generally resemble grains of sago. There may or may not be a mucous discharge."

The simple form lasts a variable time, sometimes as long as a year, but after the development to a certain degree of the granulations, the conjunctiva becomes more vulnerable and complications with a species of conjunctivitis other than trachoma usually occur. This form may pass into trachoma II, or in favorable cases or cases which have been treated, into trachoma III or IV.

Trachoma II. In trachoma II, there is usually a discharge and it is in this stage that the disease is especially infective. It is the stage in which granulations are numerous and large, or in which a papillary hypertrophy is present. It may be divided in the above sense into trachoma IIa, and trachoma IIb.

Trachoma IIa. Gelatinous granules are present all over the tarsi and in the upper fornix. In some cases the individual granulations can no longer be distinguished: they fuse into tumor-like masses or merge into a general infiltration, the tissue assuming a peculiar glassy gelatinous appearance.

Trachoma IIb. There is formation and hypertrophy of pseudo-papillæ, consisting of red-raspberry-like elevations, which mask more

or less the typical gelatinous granules. This papillary form, as it is called, is specially marked on the upper tarsus. This form may easily be mistaken for spring catarrh, and for a condition occurring as the result of any long-continued irritation or of a protracted attack of purulent ophthalmia in non-trachomatous eyes.

Trachoma III. In this stage cicatrization has definitely begun, and is more or less advanced. Islands of inflamed conjunctiva or of trachomatous granules are seen to be surrounded by a network of fine lines of connective tissue. It is in this stage that necrosis often results from the pressure of the shrinking connective tissue (post-trachomatous degeneration). The necrotic tissue may become calcareous. The cicatrization, which is typical of this stage, is generally supposed to be pathognomonic of trachoma; this statement, however, is not strictly true.

Trachoma IV is a condition in which there is a smooth conjunctiva seamed by white lines of connective tissue. This is the stage of practically complete cicatrization of the conjunctiva or of cured trachoma.

MacCallan asserts that there are many cases which cannot be definitely stated to belong to one or other category; for instance a case may be between trachoma II and trachoma III or between trachoma III and trachoma IV. But it is his experience that for teaching purposes this division of trachoma is a valuable means of differentiating between its various phases. By means of this classification of four stages, it is possible to differentiate between the severity of cases of trachoma, and to gauge the progress during treatment of an individual or group of individuals. Without any classification, it is impossible to obtain more than a general idea of such progress, an idea which is frequently erroneous.

The lines of treatment adopted in Egypt are as follows:

Trachoma I. Application of silver nitrate solution, 2 per cent.; of perchlorid of mercury solution, 1 or 2 per cent.; with or without previous scarification.

Trachoma IIa. Scraping the granular conjunctiva, with or without expression of the granulations with forceps; subsequent application of perchlorid of mercury solution, 1 or 2 per cent. Kuhnt's combined excision operation is done in a certain number of cases where cicatrization of the fornix has already occurred.

Trachoma IIb is best treated by means of Kuhnt's combined excision operation, provided the fornix is cicatrized. Otherwise the treatment is the same as for trachoma IIa.

Trachoma III. The application of copper sulphate stick or of per-

chlorid of mercury solution, 2 per cent., with or without previous scraping of the remaining granules of the cicatrizing conjunctiva.

Etiology, pathology (and bacteriology) of trachoma. Verhoeff (*Ophthalmic Record*, Oct., 1909) gives a *rapid method of staining trachoma bodies*. He prefers Wright's modification of Leishman's stain, which requires only a few minutes for its application and is applied in exactly the same manner as in the staining of blood films. The specimen is conveniently obtained by scraping the cocaineized conjunctiva with one edge of a cover-glass instead of a knife, and by making use of the tears as a diluent instead of salt solution as generally advised. If desired, the cover-glass may be previously sterilized by flaming it. The tears and scrapings collected along the edge of the cover-glass are then gently spread over the surface of another cover-glass and allowed to dry in the air. The preparation is flooded with the staining fluid, which is allowed to act one minute. Distilled water, about eight drops, is then added, until a slight scum is formed on the surface of the mixture, which is allowed to remain three or four minutes. The preparation is then differentiated by washing off the staining mixture with distilled water and allowing the water to act about one minute. The differentiation may be followed by placing the cover-glass film side up on a slide and watching the process under a low power of the microscope. The preparation is then quickly dried with fine filter paper and mounted in balsam.

It will be seen that by this method the diagnosis may be readily made while the patient waits.

Addario (*Archives of Ophthalm.*, July, 1910) has attempted to ascertain the peculiarities of the von Prowazek bodies and to differentiate them from the bodies often found in the protoplasm of the epithelial cells of the normal conjunctiva and in common conjunctivitis. He studied 5 cases of typical acute trachoma with distinct follicle formation, and found von Prowazek's bodies, in all cases, in the cell protoplasm of the conjunctival epithelium, one or two in each preparation rich in epithelial cells. He also studied various mixed and follicular forms and found bodies which were similar in form, size, stain, appearance, and contents, to those seen in acute trachoma.

To differentiate the corpuscles from those described by Bertarelli, Cecchetto and Mijaschita in the epithelium of ordinary conjunctivitis, the writer studied three cases of diplococcus conjunctivitis, two cases of conjunctival catarrh bacteriologically negative, and two cases of ophthalmia neonatorum. The same technic was used and observations made under the same conditions. In the preparations made from the diplococcus conjunctivitis he found a number of small bodies which

presented the same appearance and took the same stain as those found in trachoma. In both cases of blennorrhea conjunctivitis he found little bodies similar to those in the diplococcus conjunctivitis. In the two cases of subacute conjunctival catarrh, he also found the usual little bodies embedded in the protoplasm of the conjunctival epithelium. Addario then examined the normal conjunctiva in order to determine whether similar bodies were present, and his observation showed that the granular bodies in the protoplasm of the conjunctival epithelium are normal and of no pathogenic value either in trachoma or in other forms of conjunctivitis in which they may be found. The author adds that "For the positive recognition of the forms described by von Prowazek one must be familiar with all the different changes which can be produced in the epithelial cells of the conjunctiva during the preparation."

The writer has also investigated the question of the presence of blastomycetes in trachoma, and in 7 cases of pannus crassus he has demonstrated the presence of encapsulated blastomycetes.

Herzog (*Deutsche med. Wochenschr.*, No. 23, 1910) gave notice that he expected to prove, what he and others have long suspected, that the elements of trachoma corpuscles are identical with certain, at present unknown, forms of involution of Neisser's gonococcus. The infection in trachoma occurs by constant augmentation of these forms within the conjunctival epithelia through a symbiotic adaptation to an intra-epithelial parasitism, appearing as the well-known trachoma corpuscles. Without the least disparagement of the merits of Halberstaedter and von Prowazek in first discovering the trachoma corpuscles it must be asserted that the elements of the trachoma corpuscles have nothing to do with protozoa.

The whole ophthalmic world is waiting for further light on this subject. Meyerhof, of Cairo, assured the Editor in 1907 that, especially in a country like Egypt, where ocular gonococcal infections are extremely common and practically always associated with trachoma, the question is still more involved and puzzling.

Flemming (*Oph. Review*, March, 1910) found trachoma bodies in the genital mucous membrane as well as in the conjunctiva more frequently than merely in trachoma. This he asserted on the strength of more than 270 examinations in human beings and monkeys, and in blennorrhea neonatorum, even in the gonorrheal type. He recognized two forms which might perhaps be different stages of the same, but he admitted that he had never observed transition of one into the other. In 32 fresh cases of ophthalmia neonatorum he had found trachoma bodies 12 times, 6 times in gonorrheal and 3 times in pneu-

mococcal, 3 times without any bacterial excitant. He could not regard these bodies as the direct cause of trachoma, but what their precise influence might be no one was as yet in a position to say.

The investigations of zur Nedden (*Archiv f. Augenheilk.*, 65, p. 355) and others renders the specificity of the trachoma corpuscles, claimed by Halberstaedter, von Prowazek, Greeff and others for trachoma, doubtful. The corpuscles have also been found, as stated heretofore, in the conjunctival epithelia in blennorrhoea neonatorum, spring catarrh, follicular, simple, diplobacillus conjunctivitis and other forms, especially in those which are characterized by a marked swelling of the papillæ, independent of the etiology of the disease. The proof has not yet been furnished that the corpuscles are micro-organisms; possibly they are alterations of the cells which developed in the course of the inflammation, perhaps as reactions to the toxic action of the morbid agents. The author thinks that in order to make any progress in the researches for the etiology of trachoma attention must be directed to the chief seat of the disease, i. e., not to the epithelium and the follicle, but to the adenoid tissue surrounding the follicles. Reviewing the results of the investigations on the etiology of trachoma so far made, zur Nedden thinks we must agree with Schmidt-Rimpler, who asserted that the morbid agent of trachoma has not yet been discovered.

A. Casali (*Annali di Ottalm.*, xl, p. 70, 1912; abstr. *Oph. Lit.*, 1912) also found trachoma corpuscles in various conjunctival affections.

One hundred cases were studied, ten each of chronic trachoma, acute trachoma, follicular conjunctivitis, acute pneumococcic conjunctivitis, Koch-Weeks catarrhal conjunctivitis, Morax-Axenfeld subacute gonococcic conjunctivitis of adults, and normal conjunctiva. Untreated cases were chosen, or in chronic conditions fairly recent cases. The bodies were found only in six cases of chronic trachoma; in seven of acute trachoma, in two of gonococcic conjunctivitis of the newborn, and in one of gonococcic conjunctivitis of adults. The author is satisfied that the bodies are not specific for, nor the etiologic agents of, trachoma; that their presence in gonococcic cases does not indicate admixture of trachoma with gonorrheal infection; and that no diagnostic significance attaches to different size of granules. He doubts whether they represent a degeneration of cell bodies, for in that case the cells should show nuclear changes, and the bodies should be found more frequently in older cases. He is disposed to support the idea that they are due to a mixed infection.

The relations of trachoma to inclusion conjunctivitis. See p. 3111, Vol. IV of this *Encyclopaedia*. A. Botteri (*Klin. Monatsbl. f. Augenh.*

50, p. 653, 1912; abs. *Oph. Review*, p. 278, Sept., 1912) gives a useful summary of the history and present position of the cell inclusions discovered in trachoma by Halberstädter and Prowazek in 1907. At first it was believed that the bodies were peculiar to trachoma, but in 1909 Stargardt and Schmeichler found them in cases of ophthalmia neonatorum. This might seem to dispose of their claim to be the cause of trachoma, but it was found that they rarely or never occurred in association with the gonococcus; the clinical features of the disease also differ in some respects from a gonorrheal ophthalmia neonatorum,—it is on the whole milder, begins from the fifth to the twelfth day, and never leads to corneal complications. Similar cell inclusions have also been found in nongonorrheal urethritis and vaginitis. Inoculation of the baboon or macacus from any of these sources causes a conjunctivitis, sometimes with a formation of follicles, but never with pannus or cicatrization. On these grounds therefore a considerable group of observers believe that “inclusion blennorrhea” of children, and trachoma are two manifestations of the same disease, the different clinical appearances being due in part at least to the fact that the child’s conjunctiva is ill-provided with lymphoid tissue, and seems to be incapable of forming follicles. Wolfrum indeed states that he has been able to reproduce trachoma with cicatrization, by inoculation of material from an inclusion-blennorrhea.

Other observers, however, profess themselves unconvinced. Cell inclusions are said to have been found in the diplococcal, streptococcal and Koch-Weeks forms of conjunctivitis, in spring catarrh, and even in the normal conjunctiva. It seems probable indeed that other structures have been confused with true trachoma bodies, but even granted that they are only found in trachoma and inclusion-blennorrhea, some observers hold that they are merely degeneration products, or reactions of the cells to toxins of a certain intensity. Inclusion-blennorrhea, is found with roughly the same frequency in all parts of Europe, whereas the distribution of trachoma varies greatly. It is admitted on all hands that the inclusions are exceedingly difficult to find in the trachoma follicle itself, being confined almost exclusively to the epithelium.

Botteri gives the result of his own researches, which have extended over many years. He found that the baboon was more sensitive to the trachoma virus than the macacus; indeed in two instances an inflammation was produced which led to the death of the animal. Scrapings from a year-old case of trachoma failed to reproduce the disease, and the virus was destroyed by keeping for three hours at from 0° C. to

10° C., by four hours at 15° C., or by three hours at 43° C. It is very sensitive to drying.

With regard to inclusion bennorrhoea, Botteri observed 22 cases, of which 14 were bilateral. He notes the freedom from complications two cases having recovered though only treated with distilled water. In three out of five fathers a urethritis had been present at the time of marriage; it does not seem to have been noted whether this was a gonococcal or inclusion urethritis. In three of the mothers no inclusions could be found in scrapings from the vagina. Nine of the mothers were multiparæ; in four instances the previous children had been normal, in five they had suffered from ophthalmia. Five of the children seen a year later had no scarring. In more than half of the total number the ophthalmia was associated with rhinitis.

Cultures from these cases produced severe inflammation in the baboon, less in the macacus; the specific characters of trachoma were not reproduced however. Inclusions soon appeared in the epithelium, and gained their full development in about a week; the conjunctivitis lasted after they had disappeared. As the gonococcus produces no reaction when introduced into the baboon's conjunctiva it is evident that a different organism is here in question, and this disposes of Herzog's contention that trachoma bodies are involution forms of the gonococcus—a contention which could not commend itself to any one who had studied the two.

Botteri finds that secretion filtered through a Chamberland filter is still virulent. Probably the individual granules only pass through, not the whole body, which is too large. With regard to distribution, Botteri found inclusions only in trachoma, inclusion-blennorrhoea and fresh cases of spring catarrh; those found in the last disease were not inoculable in the baboon, and are therefore probably different from, though morphologically identical with, true trachoma bodies. Inclusions were not constantly present in trachoma. Botteri never found them associated with the gonococcus in ophthalmia neonatorum. Somewhat similar, but morphologically distinguishable, bodies were occasionally found in follicular conjunctivitis and tubercle of the conjunctiva.

Lindner (Graefe's *Arch. f. Ophth.*, lxxiv, I, 1, 1914) has also studied the virus of *inclusion blennorrhoea* and trachoma, which he successfully inoculated into monkeys. The results of the inoculation were controlled microscopically and with regard to their biologic qualities, viz., resistance to external influences, exsiccation, longer moist preservation, temperature, etc., and as to the possibility of filtration. He also investigated the total or partial im-

munity after a single infection and the relations between trachoma and inclusion blennorrhea. He found that the virus of inclusion blennorrhea of the conjunctiva of the newborn, or of the genitals of adults, if directly inoculated into the conjunctiva, almost always produced inclusion conjunctivitis. The disease may start acutely after from 2 to 6 days or subacutely after from 7 to 11 days. The microscopic proof of inclusions and free initial bodies is possible only for a few days, in acute cases abundantly, in chronic more scantily, although the disease continues. The reinfection experiments showed a certain immunity after a single infection. The virus of inclusion blennorrhea was very unstable.

The conjunctivitis produced by inclusion blennorrhea virus from the genitals of adults resembled most closely those lesions created by trachoma after longer incubation, and showed scanty or no microscopic findings. Lindner concludes that there is no absolute argument against the etiologic identity of trachoma and inclusion blennorrhea.

The histologic description of the conjunctiva of the simian after infection with trachoma virus or inclusion blennorrhea showed that inclusion blennorrhea and trachoma produce analogous changes in the conjunctiva. During the period of observation (2 years) cicatrization had not been observed. The transmission of trachoma virus to the genital mucous membrane, as the last link in the chain of proof by experiments in animals, is still to be furnished. Three such experiments were negative.

The investigations here reported, together with those published by Botteri, strengthen our views concerning the infectiousness of inclusion diseases. The virus (trachoma or inclusion blennorrhea) is more sensitive to external influences than the germs of other ocular diseases. This fact explains why epidemics or endemics do not break out among populations with highly developed hygiene, and why among such populations an infection of adults occurs so rarely. Although some questions are still unsolved Lindner believes that trachoma and inclusion blennorrhea are etiologically identical.

Czaplewski (*Zeitschr. f. Augenheilk.*, March, 1913) reports that he found numerous forms which do not correspond to cells of the body, but have a far-reaching resemblance to those organisms observed in infections by protozoa. He recapitulates some of the most important protozoa infections, particularly the course of development of the organisms, which occurs in so-called "generating cycles." As paradigms, the amœba coli, coccidium Schubeigi, proteosoma, and malaria parasites are presented. From these generating cycles the great variety of forms, which the infecting protozoon assumes in the course of in-

fection, becomes clear, e. g., of amœboids, gametes, gregarines, sporozoites, cysts, etc.

In recent trachoma preparations, Czaplewski found in the secretions and in the follicles amœboid forms, partly with formation of chromidia, and very large plasmodia with inclosures, flagellates, gametes, cysts, etc., i. e., a large number of well-characterized peculiar formations, which could be objectively demonstrated by staining and microphotography. As the infections by protozoa take a cyclic course and different stages of the parasites correspond to different stages of the disease, one can not expect to find in each case and in each preparation always the same, and, simultaneously, all forms. The investigator's object was to demonstrate and fix a large number of the forms seen by him, and to prove their dissimilarity to cells of the body and their similarity to types of protozoa.

Czaplewski's new method is a modification of the stain of Nakanishi with borax-methylen-blue. It is supplemented by examination in the hanging drop, which has the advantage that the cell formations are not damaged by pressure. This method also is very good for the study of motility and of the further development of the individual forms, because often the succession of the single forms can thereby be inferred. While his former investigations were made on the conjunctival secretions, obtained with capillary tubes, his attention was devoted in his recent researches especially to the trachoma follicles.

He concludes that, if in a number of vital preparations from the secretion and follicles of trachoma the observed forms are actually cysts and states of encystation, such formations corresponding to cysts must also be demonstrable in sections. For that purpose he used antiformin, which dissolves the tissue in microscopic sections. From further investigations he came to the conviction that the forms seen by him are closest to the myxetozoa and, perhaps, occupy an intermediate place between these and the coccidia and myxosporidia, although they have some resemblance to the gregarines.

For a long time trachoma has been considered a contagious disease, caused by protozoa. These were recently supposed to be chlamydozoa, infinitely small forms, barely visible with the best microscopes. If Czaplewski's interpretation of his observations is correct, it is a parasite of large size, besides which also the previously mentioned small forms occur as initial stages. The parasite at first enters the epithelium, through which it migrates and forms more or less superficially, by accumulation, the bulk of the follicles. Thus, trachoma in a natural way comes into a certain parallelism with amœbic dysentery, in which, in a similar fashion, accumulations in foci take place

in the mucous membrane and submucous layers. This form of dysentery is known to be propagated by contaminated drinking and bathing water. Trachoma occurs endemically chiefly in low lands among an unclean population. Hence the writer asks whether it is not possible in trachoma not only to carry infection from person to person by common towels, etc., but to acquire infection from infected water also. Certain epidemics of trachoma-like diseases are attributed to the use of swimming baths. May not in nature, Czaplewski asks, similar modes of contagion occur by protozoa, as in amœbic dysentery, which under favorable conditions may live and multiply in polluted waters and remain infectious?

Meyerhof (*Revue Gén. d'Ophthalm.*, Apr. 30, 1914) reports that all races, black and white, are represented in Egypt, and trachoma occurs in them all.

The fact that unilateral trachoma has been reported in a certain number of cases, has been held to prove that one eye may acquire immunity through the affection of the other. In the first place, before such cases can be accepted, an extremely careful inspection of the sound eye is necessary, in order to exclude the possibility of past trachoma in it. If this be done, the number of unilateral cases becomes very small, and the author's experience of late infection of the sound eye leads him to conclude that such acquired immunity does not really exist.

Meyerhof believes that a previous attack of trachoma confers no immunity. He has observed a fresh infection in over forty cases where the conjunctiva was entirely cicatrized as the result of former trachoma.

The various methods of treatment of trachoma. Tristaino has used eusylol in the treatment of trachoma in a few cases. He regards it as greatly superior to sulphate of copper because completely lacking in irritative effects, and therefore capable of being used several times daily. The solution must be freshly prepared.

The use of carbon dioxide snow in trachoma. See p. 1405, Vol. II of this *Encyclopedia*, especially the experience of G. M. Harston.

Wibo says of this remedy that the destruction of the granulations is incomparably rapid—fifteen to twenty seconds; there is an absence of pain; there is possibility of a cure in a restricted time in a large number of cases, as in an epidemic, and of limiting the progress of contagion in schools and barracks; the facility of application, and the low cost per patient; perfect asepsis of the procedure.

Prince (*Oph. Year-Book*, p. 100, 1916) also employs frozen carbon dioxide in the treatment of trachoma. He obtains a tank of liquid

carbon dioxid such as is furnished to venders of soda water. This is attached to the wall with the outlet 8 inches below the case. A half inch nipple is reduced so that a flaring ear speculum may be attached to the outlet. A piece of chamois skin is placed over the speculum and over this a napkin, pressed down with the hand so that the snow may form under considerable pressure. As the gas escapes it leaves a very dense snow filling the bowl of the speculum. It should not be too dense, else it cannot be moulded. The most favorable shape is that of a flattened olive. A 20 per cent. solution of cocain is made by dissolving the cocain in 1:1000 adrenalin chlorid solution. This is applied by a cotton-tipped probe to the upper cul-de-sac; sufficient will drain into the lower. The upper lid is inverted and a trachoma forceps passed into the retrotarsal fold, the forceps are then elevated, exposing the entire fornix and the ice applied. The exposed area is frozen 2 minutes. The lower lid is then drawn down and the lower cul-de-sac frozen. The caruncle, the plica semilunaris, and the conjunctiva protected by the external commissures are all frozen. The treatment is repeated weekly if necessary. The application to the lids suffices to clear the pannus.

Gillman (*Jour. Ophthalmol. and Oto-Laryngol.*, March, 1908) advocates the use of *jequirity* in the treatment of trachoma, and, in selected cases, believes that it gives better results than any other method of treatment. He states that the typical cases calling for the use of *jequirity* are eyes partially or completely blind from pannus or vascular keratitis, following or complicating trachomatous granulations on the palpebral conjunctiva. The author also uses it in chronic cases without corneal involvement which do not improve under milder remedies. He starts treatment with the infusion, 2 per cent. solution, and later uses the powder if the case requires it. He cites clinical cases illustrating the rapid and satisfactory improvement following its use. See p. 6721, Vol. IX of this *Encyclopedia*.

Cosmettatos (*Clinique Ophthalm.*, Feb. 10, 1908) reports good results in chronic trachoma with fresh pannus by the use of *jequiritol*. In fresh trachoma the treatment was unsuccessful. In cases suited to this remedy, among 12 he had only one unpleasant complication, namely, decided infiltration of the cornea.

Hoor is of the opinion that *jequiritol* is of no value in the changes in the conjunctiva, that is, granulations, swollen papillæ and follicles, and is contraindicated in purulent processes, but unconditionally indicated in trachomatous pannus with cicatricial degeneration of the conjunctiva. A *jequiritol* ophthalmia lasts from four to fifteen days, and may be modified by the use of *jequiritol* serum.

Melville Black recommends the use of jequirity in trachomatous pannus in the form of the powdered bean, which is dusted into the conjunctival sac. Gillman also discusses the use of jequirity in trachoma.

Goldzieher, from an experience based upon three cases, concludes that *inoculation of blennorrhea* (see **Pannus**) in trachomatous pannus is a last resort, but not more dangerous than jequirity ophthalmia. It is indicated only in pannus crassus. In his cases, after the disappearance of the inoculated blennorrhea, not only was the cornea clear but the conjunctiva had regained its normal condition.

On the supposition that trachoma may be caused by a protozoan Gifford suggests that *atoxyl* might be tried internally by direct application, or subconjunctival injections.

T. H. Butler, based on an experience in Palestine, urges great care in the treatment of purulent dacryocystitis in connection with trachoma, lest by rupturing the sac infection should take place. If 5 per cent. solutions of protargol are unavailing he advises extirpation of the sac.

OPERATIVE TREATMENT OF TRACHOMA.

Most of the following (in which operative procedures are described and illustrated in detail) is from the pen of Dr. John Green, Jr., who also wrote on the same topic for the Editor's *System of Ophthalmic Operations*.

Beard (*Ophthalmic Surgery*, p. 356, 1910) classes surgical measures in the treatment of this disease as follows: 1. Mechanical: (a) Scraping or scratching; (b) expression or squeezing. 2. Chemical: (c) Cauterism; (d) radiation. 3. Operative: (e) Curettage; (f) excision; (g) canthotomy (and canthoplasty); (h) peritomy (and peridec-tomy).

According to Lindsay Johnson the object in treating this disease must be to procure speedy outlets for the follicles and to effect such changes as will destroy the vitality of the organisms, or, at any rate, decompose or render harmless the poison present.

With the radical removal of the trachoma follicles, which give rise to scars and are responsible for the all-too-frequent relapses, a quicker and more lasting cure is certainly attained. Forty years ago surgical measures were universally distrusted. The last decade has witnessed the all-but-universal acceptance of surgical measures as the sine qua non of rational therapy in this malady. Pick (*Vierteljahresch. für die prakt. Heilk.*, p. 73, Vol. 42) states that the special advantages of surgical treatment consist in: (1) Shortening the

period of treatment; (2) lessening the liability to relapse; (3) favorably influencing the corneal complications; (4) obviating the wretched sequelæ of the disease. Despite the changed attitude of the great majority of ophthalmic surgeons, there still remain a few who either deny the efficacy of any surgical measure, or affirm that surgical are no more efficacious than non-surgical measures.

Electrolysis in trachoma. See p. 4246, Vol. VI of this *Encyclopedia*.

Subconjunctival injections in the treatment of trachoma. It is not surprising that trachoma should have been subjected to subconjunctival medication, despite the fact that the rationale of the treatment is not obvious.

Ziklossy (*Pester Med. Chirurg. Presse* No. 50, 1-2, 1895) highly extols subconjunctival sublimate injections in acute trachoma as a means of terminating pannus. It is of no avail in old pannus where there are no signs of acute infiltration.

Santos-Fernandez (*Révue gén. d'Ophthalm.*, p. 443, 1897) reports five cases of trachoma in which he used subconjunctival injections of a solution of potassium permanganate, with favorable results.

Cuenod (*La clinique Ophthalm.*, 1907, p. 147), used subconjunctival injections combined with mechanical methods in two hundred cases. Corneal complications furnish no contra-indications. Chemosis subsides in three to four days. The method is as follows: The conjunctiva is first scarified or curetted. Then a 1 to 500 mercury cyanide solution, to which is added a few drops of 10 per cent. dionin solution, is injected under the fornix, tarsal conjunctiva, bulbar conjunctiva; and one drop into the caruncle. The after-treatment consists in the use of a 1 per cent. copper sulphate and 1 per cent. iodoform ointment.

Schiele (*Klin. Monatsbl. f. Augenheilk.*, July, p. 96, 1908) rubs the trachomatous conjunctiva with iodic acid (in pencil) and injects a solution of sodium iodate subconjunctivally.

In suppurative and granular conjunctivitis not associated with corneal ulceration, and in acute trachoma with watery discharge and eczema of the lids, G. M. Pachopos (*Grèce Méd.*, 1913) recommends the administration of subconjunctival injections of *diphtheria antitoxin*. After turning back the lids the eye is first washed with boric acid and saline solutions, and one c.c. of fresh antitoxin injected in each lid, proceeding from within outward. The lids are then returned to the normal position, and with the eye closed a third c.c. is injected under the skin and muscle tissue of the upper lid. The injections are followed by pain, acute edema resulting in closure of the eye, and an

erysipelatoid eruption which overspreads the cheek and forehead. In 36 hours the inflammatory reaction disappears, lachrymation ceases, and the granules become attenuated or disappear. Three or four such treatments are given. Of 50 patients who received such treatments, 30 were practically cured, and the others notably improved; in the latter the additional use of copper sulphate and mercuric chloride led to complete recovery.

Nicolle, Cuénod and Blaizot have experimented in the treatment of trachoma by the *intravenous and subconjunctival injections of the virus of trachoma* and all are encouraged to continue its use. They consider that the virus of trachoma is filterable and that the tears are contagious, that it is destroyed by an exposure of 30 minutes to a temperature of 50 C., and that it can be preserved in glycerin for seven days, at least. They have used the subconjunctival method together with grattage.

See, also, **Subconjunctival injections.**

Massage in trachoma. In addition to the remarks on p. 7610, Vol. X of this *Encyclopedia* it may be said here that this term describes a number of closely related procedures in which the diseased conjunctiva is subjected to rubbing, with or without instrumental aid or medicaments.

Liekernik (*Centralb. für Prakt. Augenheilk.*, Feb., p. 49, 1904) uses glass balls, 8 to 14 mm. in diameter, mounted on handles. These are dipped in cyanide of mercury solution 1 to 2,000 and rubbed vigorously over the everted lids.

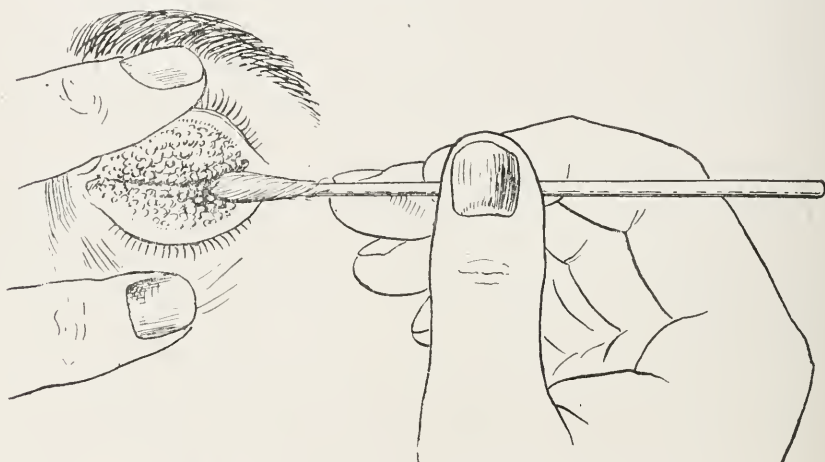
Serini (*Bollet. D'Ocul.* No. 16, 1901) dips a glass rod in a solution of iodic acid, allows it to dry and then rubs the trachomatous conjunctiva. For after-treatment he massages the cornea with cacao-butter containing dionin. Internally, iodides are administered.

Epinow (*Vratsch* XVI, p. 915, 1896) has devised a spoon-shaped horn plate to fit the upper conjunctival sac. This is rough on the upper surface and is inserted so as to bring the rough surface against the upper lid. The upper lid is anointed with vaseline and rubbed against this rough surface.

Herezogh (*Zeitschr. für Augenheilk.*, p. 81, 1906) rubs the conjunctiva with a cotton wad saturated with a 1 per cent. sublimate solution. A similar procedure is thus described in detail by Beard (*Ophthalmic Surgery*, 1910, p. 358.).

The lids are cleansed externally with warm borie acid solution. They are then everted and a single drop of adrenalin solution put on to the conjunctiva. A small hard mop is made by winding absorbent cotton on the tip of a carrier. This is dipped into a very hot solution

of sublimate, about 1 to 250 in strength, the lid is again everted and the affected conjunctiva rubbed. The rubbing should be neither too delicate nor too rough, and not prolonged beyond a minute or two, dipping the mop in the hot sublimate now and then, but never leaving an excess of liquid on it to run down over the cornea and healthy portions of the conjunctiva. Then, without replacing the lids, the whole mucous sac is copiously irrigated for another minute with 4 per cent. boric acid solution, as hot as can be borne. And, lastly, a drop of cocain solution is put in. This is repeated with two-day intervals, and, on the alternate days precisely the same is done excepting that



Massage of the Trachomatous Conjunctiva.

a 50 per cent. solution of argyrol is substituted for the sublimate. If properly carried out, there is no irritation after either treatment.

Pratt, Sedgwick (*Ophthalmic Record*, 1908), and Bordley (*Ophthalmic Record*, July, 1908) are firm believers in the efficacy of boric acid (in powder) well rubbed into the conjunctiva. The everted lids are vigorously scrubbed with a cotton-wound toothpick while an assistant continually dusts powdered boric acid on the conjunctival surface.

Noyes (*Ophthalm. Record*, Oct., 1907) everts the lids and dusts boric acid upon the conjunctiva until it is covered. The lid is then returned to position without massage.

The treatment of trachoma by negative pressure. B. M. Howley (*Amer. Jour. Ophthalm.*, March, 1919) thus describes this method: The instrument has glass attachments 120 mm. in length with a curved end 4x3 mm. that is applied to the tissues. There is a central bulb or

chamber to hold the secretions that are drawn off, and 5 mm. back of the bulb is a small opening in the tube for the finger of the manipulator to make or break a vacuum as he desires.

If the trachoma is slow to yield to this suction treatment the writer scarifies and then uses suction. Previous to scarification he washes the lids, especially the cul de sac, with a solution of boric acid, and wipes them with a solution of bichlorid of mercury 1-5,000. Cocain having been applied a small scalpel or scarifier is used.

Thickened lids and a conjunctiva of the rough, granular type, should not only be scarified, but scraped with a small scalpel, after which the suction tube is applied. These patients, as in all cases that have been treated by this method, will invariably remark that the eye feels better after the first treatment. In trachoma or in chronic conjunctivitis, especially when it is monocular, it is always advisable to see that there is no stenosis of the nasal duct.

The writer has treated about twenty-five cases of trachoma, and they have varied from the mild type to the most aggravated or severe ones. The mild cases yielded to negative pressure and if slow, a moderate scarification followed by suction yielded quick results. In these cases pressure is applied two or three times a week, followed by an application of bichloride of mercury 1-5,000, or argyrol 20 per cent. Scarification may be performed every two or three weeks as indicated by the progress of the case or the severity of the disease. Silver nitrate 1 per cent. or 2 per cent. is also of great benefit. For home treatment Howley orders mercury bichloride 1-10,000, argyrol 20 per cent. or zinc sulphate gr. 1 to 1 oz. Persistent treatment along these lines will cure some cases in three months.

The severe cases that have been progressing for years are not so amenable to this treatment, owing to the marked infiltration deposits and the formation of new connective tissue and its resulting deformity. In these cases Howley always begins as soon as possible with thorough scarification and then applies suction to the bleeding tissues.

The writer refers to his method as that of "negative pressure" and says that it draws the secretions and infection from the glands and causes resolution to a certain extent in the affected lid. The amount of negative pressure that the patient will allow will vary, but he has often applied pressure of ten pounds on the upper lid and five or six pounds on the lower lid. This is not a steady pressure, as the operator must be guided by the sensitiveness of the patient as the applicator is swept across the lid, ready to lessen the vacuum if it becomes painful. The junction of the upper lid with the cul de sac, and the cul de sac itself, are sensitive to negative pressure. The lower lid, al-

though sensitive, will stand three or four pounds of negative pressure if sweeping motions are employed. The applicator must not be pulled from the tissues as it is painful and may tear them. As a rule the average patient will bear six or seven pounds on the upper lid and three or four pounds on the lower lid without complaining.

The *actual cautery* for removal of trachomatous tissue was employed in antiquity. One can readily imagine the extensive scarring that must have resulted; but after the invention of the galvanocautery, it became possible to limit the cauterant action (by the use of fine tips) to a tiny area. Samelsohn (*Graefe's Archiv für Ophthalm.*, Vol. III, 1, p. 114, 1857) in 1857, burned the granulations with a very fine electrode.

H. Korn (*Berlin. Klin. Wochenschr.*, p. 201, 1870) passed a glowing platinum rod over the conjunctival surface in a manner similar to the application of a copper sulphate crystal.

Reich (*Klin. Monatsbl. f. Augenheilk.*, p. 56, 1888) adopted a similar method and limited the use of the cautery to early cases. The method, if cautiously employed, may be used to eradicate isolated granulations. If the follicles are numerous and generally disseminated, it will be found too tedious, requiring several seances. See p. 1788, Vol. III of this *Encyclopedia*.

Brossage, brushing, swabbing or instrumental massage. This procedure is fully described and pictured on p. 1314, Vol. II of this *Encyclopedia*.

L. Webster Fox (*Ophth. Record*, Dec., 1912) uses the Darier forceps and three-bladed scarificator and the *granular tissue is scrubbed with a toothbrush* which has been steeped in a corrosive sublimate (1-100) solution just before being used. Immediately after scrubbing the part is washed with a solution of the same strength. An antiphlogistic lotion is applied over the lids in addition to cold compresses day and night. The eyelid evertor, an instrument devised by the writer, enables the surgeon to expose the retrotarsal fold of the upper cul-de-sac with ease.

X-ray treatment of trachoma. The use of the X-ray in the treatment of trachoma was first reported by Mayou (*Ophthalm. Review*, p. 203, 1902). He was led to experiment with radiotherapy in this disease by the following considerations: The efficacy of the treatment by caustics is due partly to the production of a leucocytosis with subsequent cicatrization of the trachomatous nodules, partly to the mechanical removal of the diseased tissues, and the destruction of the specific causative agent. Caustics possess the disadvantage of partially destroying the normal palpebral epithelium, thus increasing the ten-

dency to scar-formation. The X-ray is an agent capable of producing a more or less prolonged leucocytosis from the mildest to the intensest grade, without (except under ill-regulated exposures) seriously impairing the integrity of normal epithelium. Theoretically, therefore, it should exercise a most favorable effect on trachomatous tissue.

Judging from the surprisingly rapid and complete cure in his cases, it must be admitted that Mayou's theoretical contentions have been borne out by the results of treatment. The technique of the application is described as follows: The upper lid being everted, the lower is pushed up so as to cover the cornea (in pannus the cornea is left exposed). The patient is seated nine inches from the anode of a moderately-soft tube and is given daily sittings for four to six days, followed by a week's rest. Should there be no reaction the sittings are continued twice a week until the appearance of photophobia, which indicates beginning reaction. Shortly after the trachoma bodies begin to disappear. Sittings are continued once or twice a week until the masses are no longer visible. A certain amount of injection of the conjunctiva persists for several weeks after cessation of treatment, and it is not possible to tell whether all masses have disappeared until this has subsided. Pannus disappears rapidly and old opacities and corneal scars clear up surprisingly.

The cases best suited for treatment are those of the ordinary chronic type. Acute cases exhibiting diffuse infiltrations with much photophobia require very careful management and are not so favorably influenced. Frequently the conjunctiva is left free from scars and uncontracted. The following positive advantages are claimed: (1) The cure is effected with a minimum deformity of the lid; (2) the treatment is painless; (3) pannus clears with unexampled rapidity.

Mayou's results have been confirmed by a number of observers, notably by Stephenson and Walsh (*Medical Press and Circular*, p. 77, 1903). In four cases of severe bilateral trachoma these authors subjected one eye only to the X-ray, the fellow (or "control" eye) being either untreated or treated by ordinary methods. Two cases were absolutely cured, the other two showed marked improvement, while in all the "control" eyes remained in statu quo. In the same paper the authors report the complete cure of a severe case of trachoma by the application of a mild, high frequency brush by means of a vulcanite electrode. This interesting result led them to advance the suggestion "that the common agency may be a brush discharge visible from a high frequency electrode, but invisible from the focus tube."

The two methods have been combined by Geyser (*Journ. of Advanced Therapeutics*, May, 1904) who reports eighteen cases success-

fully treated. After six to eight exposures to the X-ray, the treatment is continued, says this writer, "by the direct application to the conjunctiva of a high frequency vacuum electrode, for from one to three weeks."

A more recent experience is that of Basutinsky (*Vratsch.*, p. 12, 1905), who made a study of radiotherapy in cases of trachoma, subjecting one eye to the influence of the rays, while the other, protected by lead screens, was used for comparison. The treatment comprised sixteen seances of five to six minutes' duration covering a period of two and one-half months.

On the basis of results one month after the last seance, Basutinsky states that (1) The infiltration was diminished, and pannus was improved; (2) the trachoma follicles were still present; (3) there was no complete cure; (4) there was little tendency to scarring; (5) the method was painless and may be used where other means are contra-indicated.

It may be stated, parenthetically, that MacCallan, than whom no one is in a better position to judge, has not been encouraged by good results to continue the use of the method.

Radium treatment of trachoma. Comparatively few workers have applied radium to the treatment of trachoma and their testimony as to its value is inconclusive. Jacoby (*Deutsch. Med. Woch.*, Vol. XXXII, No. 2, 1906) states that radium has unmistakable therapeutic action. Falta passed a glass tube containing radium bromide to and fro across the conjunctiva for ten minutes daily. The trachomatous bodies disappeared in from one to two weeks but the conjunctival infiltration lasted much longer. There appears to be no danger to sight and the method, which is painless, can be used indefinitely at discretion.

Muschelow used radium in thirty-two cases and concludes that: (1) In old cases it has very slight effect. (2) The follicular type of the disease is benefited with no scars resulting. (3) Recurrences were not observed (the author admits that the period of observation was too short to permit of final conclusions on this point). (4) The method is painless and not dangerous.

Birch-Hirschfeld states that although the treatment brings about a smoothing and disappearance of the follicles, recurrences were almost invariably observed, and other therapeutic methods were necessary to complete the cure.

Selenowsky recommends *radium* in the treatment of trachoma, five-minute exposures for mild cases, ten-minute exposures for cases with extensive follicular hypertrophy. The exposure of the everted tarsal

conjunctiva for ten minutes to a maximal dose of 10 milligrams of radium bromid is not dangerous in so far as the eye is concerned. The globe itself, however, must not be exposed to the rays.

See, also, **Radium in eye diseases**, p. 10858, Vol. XIV of this *Encyclopedia*.

Lundsgaard has treated several cases of chronic and acute trachoma by means of the *Finsen light*, and noted disappearance of the granules after a few treatments. He also applied this light in exposures of five minutes in follicular catarrh, with the result that the follicles disappeared within ten days.

Curettage of trachoma bodies. The following method is enthusiastically endorsed by Sattler (*Zeitschr. f. Heilk.*, 12, 1891). Under cocain (in fresh cases) or general narcosis (to insure thorough work in one sitting), the lid is everted and held by an assistant.

The follicles of the palpebral conjunctiva are punctured with a cataract needle and the contents scooped out with a sharp curette (from 1.5 to 3 mm. in diameter). To gain access to the transition fold and plica the tissue is grasped by fixation forceps and drawn to one side or the other. By shifting the grasp of the fixation forceps one is enabled to reach every part of the fold. Several sances are usually necessary.

The reaction is slight and can be readily controlled by ice compresses. A more or less prolonged after-treatment (as with expression) is necessary.

The operation is applicable to all cases with evident follicular deposits. Chronic cases with thickened lids in which the granulations of the palpebral conjunctiva and transition folds are obscured by swelling, should be subjected to preliminary medical treatment. As soon as the follicles become visible they should be "ripped and scooped." In practice, however, this method has been largely reserved for cases in which the granulations are isolated and few.

Falta has described an operation suitable for the obliteration of clumps of little follicles which are found on the convex tarsal border of the upper lid, and for smoothing out papillary overgrowths on the tarsal conjunctiva. He had made a tiny burr, similar to a dental burr, but with shallow grooves. This is fixed in a dental engine, the upper lid is everted, a horn plate inserted into the upper cul-de-sac, and the conjunctiva is ground smooth of papillæ and granulations by the rapidly revolving burr passed to and fro under the lid.

Grattage in trachoma. In addition to the matter given under this heading on p. 5633, Vol. VII of this *Encyclopedia*, it may here be

said that the term was adopted by the French to describe a number of related procedures in which the trachomatous conjunctiva is scraped or eurented. According to Beard (*Ophthalmic Surgery*, p. 356, 1910) "scraping" is the most ancient of any of the surgical methods. At the end of the eighteenth century, Woolhouse "scraped" granular lids with a little brush made of barbs of grain.

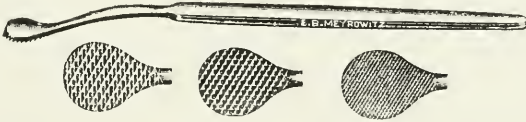
Borelli (*Giornale d'ottalmologia Ital.*, Vol. 3, 1859) rubbed out the follicles with a brush made of fine metal wire.

Strouse (*Medical News*, Jan. 11, 1896) used a specially constructed curette, with a cutting edge 1.5 mm. wide, ground sharp in its entire circumference; the lower lid was everted and rapidly scraped over its entire extent. The upper lid is then everted and held between the thumb and finger of one hand, while the curette is passed up into the fornix and this part of the conjunctival sac scraped, care being taken to penetrate all the folds. The everted portion of the lid is treated last. During the entire procedure, which occupies but a few minutes, an assistant mops the lids with absorbent cotton dipped in bichloride solution 1 to 10,000. The surfaces are washed and touched with a 2 per cent. solution of nitrate of silver. Ice pads for half an hour. Strouse states that the advantages of grattage are an uncomplicated technique, rapidity of performance, comparative painlessness, minimum injury to the tissues, absence of inflammatory reaction after operation, simplicity of after-treatment and absence of recurrences.

Egbert (*New York Medical Journal*, March 21, 1908) devised two curettes, one sharp and one blunt, "which are so constructed that all portions of the involved conjunctiva, including the superior fornix and retrotarsal folds, can be reached and the edge is so fashioned that while all granular and hyperplastic material can be readily removed, there is little danger of injuring smooth healthy tissue. The edge of the sharp instrument points downward and backward to an angle of about 45°, and when the instrument is drawn by the handle, readily engages and removes the abnormal tissue. On the sides of the spoon the edge merges into the flat metal so as to prevent side-cutting or laceration. In using these curettes the upper lid is everted over a horn or metal spatula and the sharp curette, the handle of which is held between the thumb and the first and second fingers, much as an ordinary spoon is held, with edge forward, is pushed over the eyeball well up in the superior cul-de-sac and then drawn downward from all directions of a segment of a circle, similar to that outlined by the brow. Firm, though gentle, pressure is necessary and the curetting must be thoroughly done. The blunt curette is now substituted for

the sharp one and the process repeated with slightly more pressure until the tissues feel smooth under the instrument. The upturned portion of the conjunctiva is next similarly treated, the edge of the eurette being turned downward. The lower lid is then likewise freed from all granules."

A highly ingenious and effective instrument for grattage is the so-called "trachomatome" devised by Jameson (*Ophthalmic Record*, p. 65, 1901). The following is the author's description, slightly abridged: This instrument is planned on an observation that a pyramid of steel when placed with its apex against a mucous membrane susceptible of indentation and passed to and fro with moderate pressure will not merge in it but glide over it, producing undulations. This fact applies also to numerous pyramids as represented in the instrument. This is not the case, however, should the membrane be interspersed with elevations such as exist in trachomatous membrane. As the instrument passes over the surface there is a sense of resistance



Jameson's Trachomatome.

and on inspection it will be found that the trachoma bodies have been attacked and ruptured, the interstices and normal tissues remaining, for the most part, intact. Jameson is confident that this instrument possesses distinct points of utility as follows:

(1) For grattage it places within reach of the operator a graded system of instruments (there are three in the set) adapted to the size of the granules or excrescences to be attacked. (2) It is an instrument selective of granulation elements and, per contra, one which preserves to the greatest degree normal tissue. (3) It is adapted not only to the primary operative, but in the post-operative treatment, in the course of which secondary growths may appear. (4) As an adjunct to the expression operation it opens avenues in affected tissues, rendering expression easy and accomplishing it with less trauma.

In operating on the lower lid the trachomatome is placed between it and the eyeball and pressed well down against the former. Counter-pressure is made by a curved index finger pressed against the lid from without. On the upper lid a double eversion is made, and having gone over the posterior exposed part the forceps are released and the everted lid grattaged against the tarsal cartilage, which makes a good

resistive surface. Care, however, is especially required at this step as the curve of the everted lid lies in contact with the cornea and overlying pyramids may injure it if left unguarded. Lastly, the lid having assumed the normal position, it may be grasped between fingers, stretched, and the desired instrument swung to and fro over its entire surface.

Coover's sandpaper grattage. A method of grattage and one which enjoys extended popularity by reason of its efficacy and simplicity, has been described by Coover (*Ophthalmic Record*, Feb., 1909). Under general anesthesia, the upper lid is grasped by Darier's forceps and turned to bring the retrotarsal fold into view. A horn speculum is inserted beneath the lid to protect the cornea. O or OO sandpaper, in strips 3 to 4 inches in length by $\frac{3}{4}$ of an inch in width, previously sterilized by soaking in alcohol and burning it off, is rolled lengthwise over the index finger. Holding it firmly between the finger and thumb, the entire lid surface is thoroughly and briskly rubbed. By folding or rolling the strip of paper in different ways all the recesses can be reached and the entire surface rubbed down smooth. If the lower lid is involved, it should be treated in exactly the same way. If there are any granulations on the bulbar conjunctiva, the operator need not hesitate to smooth them down also, of course using care and more gentle pressure.

The surface of the lids and entire conjunctival sac are now thoroughly cleansed of blood and adventitious sand particles. A moist dressing is applied and held in place by a light yet firm bandage. Cold applications are used for the next five or six hours and the eyes cleansed at intervals. The following day the conjunctiva will be found covered with a slight exudate which remains several days. Silver nitrate 2 grains to 1 ounce is applied once in twenty-four hours to the everted lids. After the exudate disappears 1 per cent. ichthyol in vaseline is used once daily, or 1 to 500 solution copper sulphate is used until the induration or thickness has disappeared, which it does in from three to four weeks.

The advantages claimed for this operation are: (1) That it is applicable to all forms of trachoma. Even in old cicatricial forms it acts curatively, smoothing down the rough and hypertrophied portions of the conjunctiva. (2) There is very little reaction. In no cases operated on by Coover had there been a severe irritation or a single corneal complication. By this method the smaller granulations in process of development are removed and the after-treatment with caustics is unnecessary.

Ryerson (*Annals of Ophthalm.*, Oct., 1906) in the *surgical treat-*

ment prefers Darier's "grattage." Under general anesthesia, the lower lid is everted by special forceps and scarification made with a three-bladed knife, so as to divide every granulation. If the lids cannot be completely everted, he divides the outer angles. If the caruncle is also infected it is removed with scissors. The scarifications cause the gelatinous material to escape, and care must be taken not to allow it to remain in the wound. The conjunctival surface is thoroughly scrubbed with a hard toothbrush moistened with a 1-1500 solution of cyanid of mercury. The reaction is marked, but may be controlled by iced boric acid or acetate of lead compresses.

The successful use of grattage is dependent upon proper choice of the case, the best result being obtained in the severer forms of papillary granulations, though the sago-grain form is also benefited. In old atrophic trachoma it is useless. The treatment must be thorough and not leave a single granulation to act as a center for reinfection. The operation should be followed by careful medication.

In his treatment of trachoma, Imre (*Ophthalm. Record*, Jan., 1906) is influenced by the amount of the inflammation and secretion, the state of the follicles, the papillary hypertrophy, the thickening and degeneration of the tarsus and the sequelæ (trichiasis, etc.). Of the chemical remedies, *lapis divinus* [a fused mixture of cupric sulphate, alun and camphor] and copper are still much in use; they relieve the infiltration of the mucosa and contract the blood vessels, act as disinfectants and diminish secretion, but, on the other hand, they hasten the formation of scars and cause trachomatous follicles to become harder. This result is not desirable, because the conjunctiva becomes thicker, more uneven, and a cure becomes impossible. The ideal treatment for these follicles and infiltrated plicæ is the mechanical one. In the course of this mechanical treatment it is desirable that as little injury and irritation be done as possible. The soft granules it is possible to express with the roller forceps, but the author is more in favor of an abrasion of the granules, as this procedure causes less injury to the mucosa. Galvanocautery should be employed only when the affection is extensive. Excision of the fornix is rarely necessary. Excision of the tarsus is quite efficient.

Excision of conjunctiva in the treatment of trachoma. Doubtless most ophthalmic surgeons will agree that practically all of the surgical procedures described above have in common the serious drawback that they do not insure against relapses, even when followed by prolonged after-treatment. And the reason for this is not far to seek. The seat of predilection for the trachoma follicles is the upper fornix. Hidden in folds of conjunctiva and deeply recessed, they are difficult

to reach by any form of surgical attack. Expression, brossage, scarification, etc., may succeed in ridding the conjunctiva of much of the offending material, but here and there remain follicles that have escaped. It is these that are responsible for the auto-reinfection.

A realization of the inefficacy of surgical measures which had for their object the eradication of the individual follicle led Benedict, in 1822, to advocate the bodily removal of the trachoma-bearing upper conjunctival fold. It appears that this suggestion received little or no support and the practice fell into disuse, until revived by Galezowski (*Recueil d'Ophthalm.*, p. 134, 1874) in 1874.

The technique of the operation is as follows: The lid having been everted, one blade of Galezowski's double-pointed tooth forceps is passed into the cul-de-sac. The teeth are engaged in a fold of conjunctiva which is drawn downward and the forceps are closed over it, thus giving control of the operative area. A piece of conjunctiva 3 to 8 mm. wide and as long as the fornix is excised by scissors dissection. No sutures.

Galezowski was well satisfied with the results of excision, both immediate and remote, especially as it offered a partial immunity against recurrences. The operation, though correct in principle, was incomplete, for no account was made of the subjacent tarsus which was usually seriously compromised.

It remained for Heisrath (*Berlin. Klin. Wochenschr.*, 28, 29, 30, 1882) to supplement the Galezowski operation by excising a strip of tarsus along with the fold of conjunctiva. This device marked a tremendous advance in the operative treatment of certain intractable cases of chronic trachoma, and developed and modified by Vossius (*Bericht der Ophthalm. Gesell.*, p. 186, 1884) and Kuhnt (*Klin. Jahrbuch*, 1897, p. 413) it has proved of inestimable service in a class of cases once the despair of victim and surgeon alike. Kuhnt, practising in a district (Koenigsberg) where trachoma is endemic, had ample opportunity to put into application the modifications of Heisrath's procedure suggested by experience, and to determine the indications and limitations thereof. Three closely related procedures are the outcome of this experience. They are: (1) Simple excision of a strip of infiltrated fornix. (2) Combined excision, i. e., removal of a part of the tarsus together with a strip of infiltrated fornix (chiefly applicable to the upper lid). (3) Extirpation of the tarsus. The last two operations are described farther on in this section.

Simple excision is the operation of choice for the *lower fornix*. Its indications are, according to Beard: First: When other methods have failed, or when there are relapses. Second: When the tarsus or

the bulbar conjunctiva are becoming involved. Third: When there are corneal complications. Fourth: When the patient comes from a trachomatous district and will go back to it. The operation is contra-indicated when the conjunctiva is at all scant.

Technique. One method of performing this little operation is as follows: The point of a hypodermic syringe (filled with a 4 per cent. solution of cocain) is thrust horizontally into a fold of conjunctiva (seized and raised near the outer commissure) and advanced the whole length of the lower fornix. In withdrawing the syringe 4 minims are injected into the subconjunctival tissue. This artificial edema renders the granules in the folds very conspicuous. With the fold stretched by an assistant the operator circumcises it with a scalpel. The end of the fold is held up with forceps and the whole strip excised with scissors. Sutures are usually omitted.

Pterygium occurring in a trachomatous eye greatly hinders recovery and *should be removed*. Falta has even observed complete cessation of the trachomatous process after excision of a pterygium.

Spasm of the orbicularis incident to pannus is favorably influenced by canthotomy; also by forcible stretching of the lids (Hornback (*St. Louis Med. Review*, p. 173, June, 1910)).

To *diminish pressure on the cornea*, Mulder (*Med. Weekblad*, p. 180, 1895) excises a strip of skin and muscle from the upper lid.

Canthoplasty in trachoma. A description of conditions in trachoma that requires canthoplasty, and of a form of operation (a modification of Kuhnt's procedure) devised to meet these special conditions has been published by Jesse S. Wyler (*Amer. Jour. Ophthalm.*, April, 1918). The present operation finds its principal advantage in cicatricial stages, with pannus, blepharophimosis and entropion, where a removal of the diseased conjunctiva is impractical, because nature in her effort to cure, has converted the entire sac into a shrunken mass of scar tissue. The sac is greatly contracted, with no healthy mucous membrane remaining and this contraction has narrowed the lid fissure and caused distortion of the lids. The end results of the diseases thereby produced are: (1) Insufficient ventilation and poor drainage; (2) undue pressure upon the globe with a corresponding increase in corneal destruction; (3) subjective suffering from the blepharospasm and trichiasis.

Instead of applying copper sulphate or silver in these conditions and thus augmenting the already great physical sufferings, with little real benefit, it behooves us to utilize a radical measure which will relieve the blepharospasm and enlarge the lid fissure to get improved drainage and make topical applications easier and more efficient.

The first real attempt at operation was made by David Prince in 1866, but a close study of his method reveals the fact that the correction of the existing entropion appealed more strongly to him than the widening of the fissure, and it is this result that is produced. Since Prince's time many modifications and new procedures have been published. The ordinary canthoplasty uses the dissected conjunctiva to cover the tissue denuded by the splitting of the lids, but this proves unavailing in trachoma as the contracted, scarred membrane is already too small for its required function. It therefore devolves upon the operator to use a method of preventing the healing of the divided lids by other means. Although the writer's method approaches that of Kuhnt in theory, the technique and application vary considerably. The idea is based on the use of a small skin flap to cover the denuded canthal angle.

Its performance is possible in any complication, and can be made practically painless with local anesthesia.

The instruments necessary are few. A horn plate, keratome, fine tooth forceps, straight, strong scissors, needle holder, a black silk suture doubly armed with medium-sized curved surgical needles, and hypodermic syringe for the anesthesia.

The lids and surrounding tissue are wiped with benzine and then washed with soap and water. Wyler refrains from the use of iodine when skin flaps are required around the lids. The conjunctival sac is washed out with a sterile solution and the rest of the face is covered with gauze saturated with 1-1000 bichloride of mercury.

The conjunctival sac is then cocaineized with 2 or 3 drops of 4 per cent. cocaine solution. The syringe is filled with 6 parts of 1 per cent. cocaine to 2 parts of adrenalin solution, and the needle inserted on the conjunctival surface of the outer angle, penetrating horizontally under the skin to a distance of about 5 mm. past the orbital rim. Only a few drops are used, but a wait of about five minutes is necessary to obtain the full advantage of the anesthesia and anemia.

After inserting the horn plate to protect the eyeball, the temporal side of the lids is put on the stretch, and the extent of the flap to be dissected is outlined with the point of a keratome. This tongue of skin starts about 2 mm. beyond the orbital edge and 2 mm. above the horizontal prolongation of the lid fissure, is carried nasally for half the distance to the outer angle, curves around and returns to a point 2 mm. below the horizontal exactly under the first incision. See the figures. This small skin flap is now carefully dissected up in its entirety and laid back on the temple. Inserting one blade of a straight scissors into the conjunctival sac, a horizontal canthotomy is made,

reaching to the bony edge of the orbit. The bleeding is very slight, due to the adrenalin.

The double armed suture is now inserted through the tip^s of the flap from the skin surface inward. The needles are then passed one above, the other below the line of the canthotomy, horizontally entering under the palpebral-conjunctiva in the extreme angle, passing over the bony edge under the skin of the temple and making their exit about one-half inch from the rim of the orbit.

When these two ends are finally tied over a small roll of gauze, the flap is pulled between the cut edges of the skin and lines the angle, readily assuming the crease made by the pressure of the lids, and preventing the denuded surfaces from adhering. No dressing need be applied, as Wyler finds the open treatment most favorable for wounds in this locality. The suture is removed on the third day.

The advantages of the method are: first, the operation is easy to perform; second, it makes a permanently large fissure; third, the patient suffers little discomfort, and need not remain in bed.

Operations for trachoma in which a general anesthetic is usually given.

Expression of the trachoma bodies. The idea of squeezing out the contents of the follicles with thumb and finger—*unguipressio*—is an ancient one of uncertain origin. It was used and advocated by Eble (1828), Pilz (1854), Cuignet (1873), E. Berlin (1878), Leber (1878), Wolfe (1882), and Mandelstamm (1883). In the United States Hotz (*Archives of Ophthal.*, Vol. XV, p. 147, 1886) was one of the earliest advocates of expression. According to Beard he devised the original expression forceps by smoothing the jaws of a pair of old angular forceps.

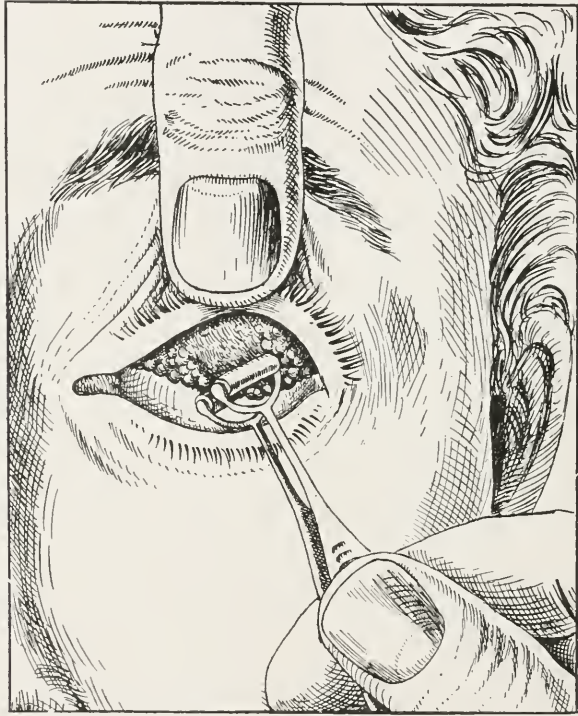
In 1889, Prince presented to the Illinois Medical Society his well-known ring forceps. Shortly afterward appeared the trough-shaped forceps of Noyes, and from this time the operation began to receive general acceptance.

It was not, however, until Knapp (*Trans. Am. Ophthal. Soc.*, p. 148, 1891) presented to the profession his ingenious roller forceps that expression of the trachoma follicles became practically universal.

After experimenting in a few cases with Prince's and Noyes' forceps, it occurred to Knapp that an instrument acting on the principle of a mangle would express the granulations as well and with less bruising and laceration of the tissue. Acting on this idea, he had made the "roller forceps," which consist of "two creased cylinders, about two millimetres thick and ten or eleven millimetres long, rolling on

pivots in horseshoe-shaped ends at the shafts." To insure rolling the surface of the rollers must offer resistance, hence the creases.

The following is Knapp's description of the technique of expression of trachoma granules with roller forceps: "To express trachomatous infiltration both thoroughly and with the proper care not to wound the cornea nor bruise or lacerate the conjunctiva, is painful and requires time. I therefore, as a rule, use general anesthesia. As the



The Operation of Rolling or Expression. (Knapp.)

operation has proved harmless, I operate on the four lids at the same sitting."

The upper lid when everted should be seized at its edge with the (roller) forceps at the center of the retrotarsal fold drawn upward, so that the whole extent of the granular deposition shall be exposed. Then the lid is held everted with the index-finger, and one cylinder is pushed deep into the upper fornix over the edge of the lower lid, which, remaining in situ, protects the cornea. The other cylinder passes over the tarsal surface of the conjunctiva. The forceps is now compressed with moderate force and drawn forward, so that we notice

the even rolling of the cylinder that lies on the tarsal surface. The granules come out more or less crushed by the cylinders, and if they are soft their contents are seen only as a gelatinous liquid. The forceps is introduced and the manoeuvre repeated again and again until all trachomatous substance is pressed out. At first the tissue caught between the rollers is thick and resistant, but gradually it thins down and, when all the infiltrated substance is out, the retrotarsal fold stretches as a thin, double-up membrane between the cylinders. Then the center of the fold should be drawn up and inward so as to unfold and stretch out the portion concealed behind the outer commissure. This portion is then pressed out with the roller as thoroughly as the central portion. The same ought to be done with the lower lid and the caruncle. If, which is not rare, the tarsal surfaces of the lids are also beset with granules, these can best be pressed out if, on the lower lid, one cylinder passes over the outer and the other over the inner surface. On the upper lid this need not be done, as the longer and thicker tarsus gives sufficient resistance for the roller to liberate also the tarsal surface from the included granules. The impressions from the ridges of the cylinder give to the surface a fluted appearance which must be uniform, i. e., free from granules. On inspection the whole retrotarsal fold with the canthal portions should be entirely free from granules, and present a dark-red surface with a number of small redder dots, apparently the cavities of the granules now filled with blood. The surface may or may not be washed over with a small pad of absorbent cotton dipped in a solution of bichloride of mercury 1:500.

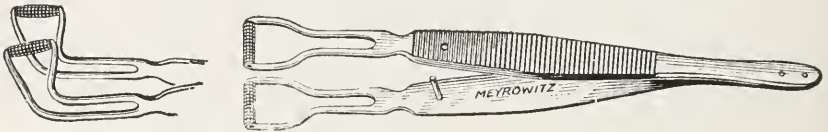
Ancil Martin, a trachoma operator of wide experience, uses in the right hand a Knapp's roller forceps and in the left a Noyes'. Everting the upper lids he grasps the folds with the Noyes' and "milks" with a Knapp's. Reversing the procedure when advisable, he fixes with a Knapp's and expresses with a Noyes'. The latter method is especially satisfactory for the removal of the trachoma bodies from the canthi, and in "nursing" them from the bulbar conjunctiva. Traction should also be made from the firmer palpebral conjunctiva toward the equally separated bulbar conjunctiva and never the reverse.

After some practice one will find that he is using both hands, thus making the operation a very rapid one. Particular attention should be given to the careful removal of the bodies from the line of the folded upper lid. Should this step be overlooked, it will be discovered later that there is a transverse line of trachoma bodies along the center of the upper lid just in the situation most likely to create corneal friction.

Some operators perform linear scarification of the conjunctiva preliminary to expression.

Post-operative care. If the operation is judiciously performed, there is surprisingly little reaction. Gauze pads, chilled by contact with ice, are applied to the closed lids and frequently renewed. Some operators prefer frequent douching with hot sterile water or saline solution. The day following the operation the lids, though somewhat swollen, can be opened spontaneously. On eversion one observes a yellowish-grey exudate in the form of a slightly adherent pellicle covering the conjunctival surfaces. This should not be disturbed as it will come away gradually at each successive irrigation. The conjunctival surface should be copiously douched with normal saline or boric acid solution, and the lids and the margins anointed with a bland ointment.

On the second or third day a probe should be passed to the upper and lower fornices and gently drawn across from the inner to the



Claiborne's Roller Forceps for Expression of Trachoma Follicles.

outer angle, for the purpose of rupturing any adhesions which, if left undisturbed, would give rise to symblepharon.

D. W. White believes that the best preventive of symblepharon is castor oil, instilled immediately after the operation.

Various other expression instruments for trachoma operations. The mechanical principles underlying Knapp's instrument have been utilized by ingenious ophthalmologists in an effort to obviate real or fancied deficiencies.

In Campbell's modification the ends of the cylinder project beyond the ends of the shaft. Rust made one arm a straight prolongation of the shaft, the other turning off parallel with the cylinder. Both modifications were designed with the object of gaining readier access to the granulations of the external and internal canthi. Falta (*Trachom-Therap. in der Versuechtesten Gegend Ungarns*, Berlin, 1906) has constructed a roller forceps, the cylinders of which are perforated, the holes of one cylinder opposing a space between the holes of the other cylinders. This embodies the principles of Knapp's rollers and Kuhnt's expressors.

J. H. Claiborne's rollers have parallel rows of fine points instead

of flutes. With these forceps the granulations are first lacerated and then squeezed, combining the processes of grattage and expression. Claiborne's contention that with this instrument the operation is attended with less trauma and insignificant post-operative reaction is well founded. The Editor's experience with this instrument, extending over a period of several years, has been a most happy one.

W. Norton Whitney (*Annals of Ophthal.*, Jan., p. 57, 1910) has modified Knapp's forceps by replacing one of the rollers by a "flat, wash-board like terminal, over which the remaining roller is made to pass so that the fold of conjunctiva between these two surfaces can be subjected to the necessary pressure without pulling or stretching it unduly. The motion is obtained by means of a double hinge at the end farthest from the roller." This instrument was designed to obviate, to a large extent, the common defect of roller forceps, viz., the "traction exerted upon the membrane in stripping the follicles." (Beard.)

Expression forceps, in which the roller principle is not utilized, have been devised by Martin Cohen (*Phila. Med. Journ.*, Aug. 29, 1903) and Jas. Hancock (*Med. Record*, Jan. 26, 1901). Cohen's instrument is shaped like an artery forceps having a French lock fulcrum between the blades and handles, the latter being reinforced by a removable spring. The handles are so curved as to allow for the inspection of the entire field of operation. The crushing surfaces are furnished with two horizontal grooves and are small enough to gain easy access into the canthi. A thumb rest on the posterior blade steadies the instrument while in use. The method of its application is as follows: Having everted the lids (using two of these instruments, one to steady the lid) the compression surfaces of the blades grasp the granulations, the operator being thus able to apply and control the requisite force. The advantages claimed for this instrument are: (1) The liability of injuring the conjunctiva by removing the granulations is lessened. (2) The operation is not followed by the unpleasant effects that attend the employment of other instruments, such as adhesions, inflammatory changes, granulations, and scars.

Hancock's instrument consists of opposed stationary cylinders of moderate size and absolute smoothness. It does not become clogged with blood, a fault common to most instrument of the roller type.

See, also, under **Forceps**, p. 5256, Vol. VII of this *Encyclopedia*.

We have considered those instruments which empty the follicles, on the principle of the mangle and those which perform their office by the combined effects of pressure and traction. There remain to be described instruments in which the principle of *pressure alone* is

utilized. The best known is the *forceps expressor* of Kuhnt (*Zeitsch. f. Augenheilk.*, Oct., p. 389, 1909) with its modifications. The working part of this instrument consists of two perforated metal plates, each perforation coming in apposition with an unperforated portion of the opposite plate. The modified expressor has a perforated and unperforated plate. The modified instrument is used in gelatinous degeneration of the fornices, by inserting the perforated blade beneath the uninverted lid and making pressure.

Jameson's forceps for trachoma. One of the best and most useful of the modifications of Kuhnt's device has been arranged by the inventor of the *trachomatome* (q. v.). These are of several shapes and sizes, adapted to individual requirements, and have been used to great advantage by the Editor and his assistants.

Best period for expression. This procedure is most successful when the follicles are exuberant or begin to show softening, i. e., when the disease is entering upon its second stage. Elschnig regards "expression" at this period in the development of the disease as the operation of choice. It is contra-indicated in acute trachoma, in cases of follicle formation in the transition fold, during an acute exacerbation and in the cicatricial stage. The operation may require repetition one or more times. Follicles which have escaped destruction may give rise to auto-reinfection. In severely infected regions the operation does not safeguard the conjunctiva from extrinsic reinfection.

Anesthesia in expression operations. In the earlier days general anesthesia was unquestionably the rule, and is still indispensable in a minority of cases; e. g., excessively nervous individuals, some children, etc. Fair anesthesia is usually secured by the subconjunctival injection of a 2 per cent. cocain solution. D. W. White has used; with entire satisfaction, powdered cocain dusted on the palpebral conjunctiva. The operation is begun from one-and-a-half to two minutes later. He has used the method in nine hundred patients ranging in age from five to sixty years.

Although expression has received very general acceptance, it must not be imagined that the method has altogether escaped censure. An excellent summary of the principal objections that have been advanced against expression is given by Strouse as follows: "(1) The forcible expulsion of the trachoma follicles produces extensive laceration of the delicate conjunctival tissues. (2) The deeper-seated follicles are evacuated with difficulty. (3) The pressure required to eradicate the disease thoroughly, especially if, as frequently happens, the roller of the instrument does not rotate but glides over the surface, is so considerable that the underlying tissues are subjected to severe con-

tusion which retards healing of the affected parts. In consequence of this the reproduction of normal epithelium after expression is impaired and an excess amount of cicatricial tissue is produced."

In his operative work among the Indians C. H. Dewey (*Ophthal. Rec.*, April, 1914) has performed a great many expression operations for trachoma. As a large percentage of the cases were in children it caused him to consider the anesthetic and instruments that cause least discomfort to the patient and yet afford rapidity and efficiency in his work.

The patient is prepared in the usual manner for operation; then, to check the smarting of the stronger cocain application a drop of 4 per cent. solution of cocain hydrochloride is instilled in the conjunctival sac and repeated in four minutes. After a few minutes the patient is placed on the operating chair and powdered cocain applied to the everted lids with a dampened cotton-wound applicator, special care being given to the conjunctiva of the retrotarsal folds and the inferior cul-de-sac, which is very sensitive. In from one and one-half to two minutes the anesthesia will permit of an almost painless expression. Though the cornea has in a few instances become steamy Dewey has had no bad results in over 500 cases. The cornea is kept flooded with a warm saturated solution of boric acid during the operation. This method of anesthesia will permit one patient to go through the preliminary preparation while another is undergoing the operation. The one in preparation gains courage when he sees that the other suffers so little; thus no time is lost in persuasion or in offering explanations.

The upper lid is everted and granules removed from the tarsal plate and retrotarsal fold by placing one blade of the expression forceps (Prince's, Noyes' or Knapp's) in the fornix and the other over the tarsal plate, then, with firm pressure, the granules are stripped from their bed. When the tarsal plate appears to be clear of granules, "grasp the superior margin of the tarsal plate with a pair of forceps (Prince's) and make a second eversion, asking the patient to look down. This gives an excellent view of the entire retrotarsal conjunctiva where the granules are most numerous and furnishes an opportunity to remove every visible granule.

"Not infrequently after what appears to be a thorough expression, when the débris is wiped away with a pledget of cotton, a number of granules will have been missed, especially in the outer canthus. Some of these seem to evade the forceps and are annoying to the operator." To overcome this difficulty the writer has devised what he calls a trachoma burr,—an olive-shaped burr milled in its entire circum-

ference, having one side smooth. With a rubbing and half turn of the instrument the granules that are so elusive and so resistant to after-treatment are removed.

Frequently when the granules are sparse and small he does the entire operation with this burr. It removes the trachomatous tissue readily and causes the least discomfort of any method he has used.

The granules on the lower lid are expressed in practically the same manner as those on the upper, but the procedure is more difficult for the beginner. The thumb nail should be placed firmly against its outer wall to steady the tarsal plate which is narrow and hard to manage with the forceps. Here the trachoma burr may be used to advantage. A repetition of the operation is rarely ever necessary if the after-treatment is not neglected.

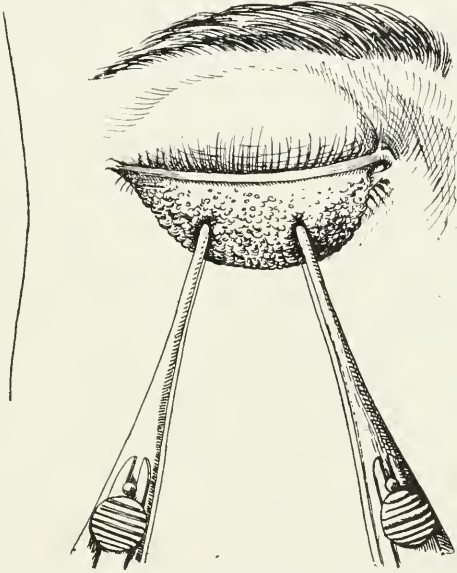
Having completed the operation the conjunctival sac is flushed with a warm solution of boric acid or is wiped clean with a cotton pledget, one drop of 1 to 1000 adrenalin solution and one of 25 per cent. solution of argyrol are instilled. The patient is put to bed or in a comfortable reclining position and compresses applied to the eyes as hot as can be borne. These are changed at intervals of a few minutes,—the patient usually indicating when they begin to cool. To protect the hands and permit of the application of hotter compresses a wringer is made from a strip of cotton flannel five or six inches wide and approximately ten inches long, with a hem on both ends sufficiently large to pass sticks for handles. The compress is placed in this and the handles twisted until it is sufficiently dry.

When the patient is free from pain,—usually in from thirty minutes to an hour, or at most, two hours—the compresses are removed and after an hour he is permitted to return to his home, if near, and instructed to report for treatment the following morning. It is much better for the patient to spend the first night in the hospital.

For two or three mornings the lids will be adherent. These are usually cared for by the patient with the aid of hot water, if not, they should be opened by moistening with warm boric-acid solution and the secretions loosened and removed with a pledget of cotton. The conjunctiva is flushed with the same solution and a drop of 25 per cent. solution of argyrol instilled. Light treatment should be continued daily for a week when the patient will be ready for the regular routine treatment, which is as yet not standardized.

Since there is so much discussion as to the proper procedure after operation Dewey submits without comment, a copy of the instructions he leaves with the nurse who carries out the after-treatment. It has given him the best results and causes very little discomfort to the

patient. It is a daily treatment for trachoma: (1) Inspect conjunctiva and cornea for abnormal conditions; (2) flush eyes with warm saturated solution of boric acid or normal salt solution; (3) (when copper sulphate pencil is not used) dust powdered boric acid on everted lids with cotton pledget, use friction massage; (4) (when copper sulphate pencil is used) instill one or two drops of 4 per cent. cocain solution (for few weeks only); (5) apply copper sulphate



Excision of the Tarsus in Trachoma.

First act. Eversion of the upper lid with forceps. (Kuhnt.)

pencil; 1 per cent. yellow oxide of mercury ointment; 5 to 10 per cent. copper citrate ointment or 15 per cent. thiosinamin ointment, if ointment is used massage lightly; (6) if copper sulphate pencil is used flush out eye to remove excess of copper (pencil should be applied lightly to tarsal plate and fornices).

First and second stages: Mondays, Wednesdays and Fridays use yellow oxide ointment. Tuesdays and Thursdays use copper citrate ointment. Saturdays use copper sulphate pencil (also Wednesdays if instructed).

Third stage: Same as above, except on Wednesdays and Saturdays use thiosinamin ointment.

Excision of the tarsus (tarsectomy) with the overlying conjunctiva. Heisrath's operation. The chief purpose of tarsectomy in trachoma is to remove diseased foci situated in the deep structures of the lid. It

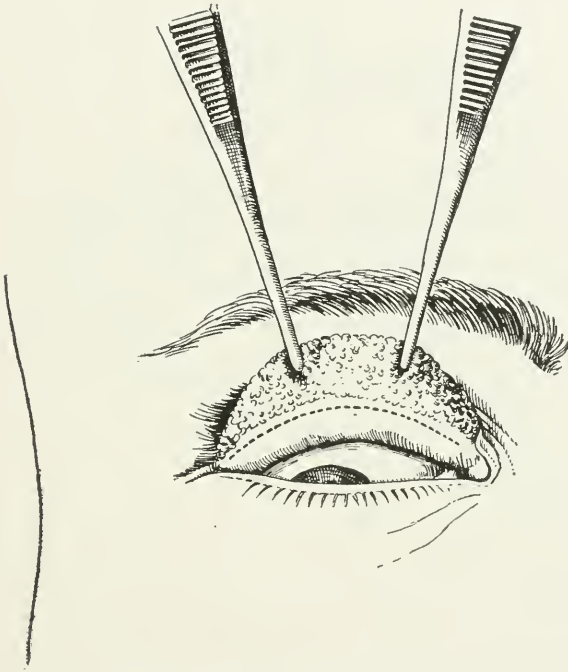
is the result of a belief that it is not a sensible procedure to treat the conjunctiva when the active center of infection lies principally or alone in the so-called tarsal cartilage.

This operation has had enthusiastic supporters in the United States, notably Casey A. Wood (*Annals of Ophthalm.*, p. 372, 1898; and the *Amer. Journ. of Ophthalm.*, July, 1903) and Frank Brawley (*Ophthalmic Record*, Oct., 1905), who have given clear and detailed descriptions of the various steps of the procedure. The following excerpt (from Wood's second paper) will furnish the reader an adequate conception of this highly important procedure: When the operation is done, as it usually is, on the upper lid, the latter is everted so that the convex border of the tarsus is thoroughly exposed. This is now firmly grasped by two strong, toothed forceps at the junction of the middle with the outer and inner thirds of the tarsal margin, and drawn firmly upward by the assistant standing at the patient's head. The junction of the palpebral and ocular conjunctiva is now fully exposed and may be readily examined. Following as nearly as possible the margin of the diseased area, an incision is made from the outer to the inner canthus through the conjunctiva only. Unless, in consequence of previous mechanical treatment, the conjunctiva is bound down to the underlying tissues, the wound will gape and the fibres of Mueller's muscle may be recognized. Three stitches should now be passed through the bulbar margin of the incision, care being taken to include only the conjunctiva and a few fibres of the submucosa. If more than a mm. in width of conjunctiva is included in the sutures, small symblepharon folds may form opposite each stitch, and if too deeply inserted there will be a noticeable dragging on the lid edges.

A word as to the sutures. Frank Brawley has prepared a modification of the black silk (preferably No. 2 black braided) which Worth advises in his advancement operations.

The silk is first wound upon ordinary glass microscopic slides (for convenience of handling) and sterilized by boiling thirty minutes. It is then dehydrated by immersion in absolute alcohol for ten minutes and the drying process assisted by holding the slides a few feet above a Bunsen burner flame for a few additional minutes. The slides of silk are then dropped into a jar of paraffin containing 25 per cent. of vaseline, where they remain until used. Each time they are used the jar containing the silk is resterilized by heating, an end of suture is drawn out of the jar and the excess of wax is "stripped" off the required suture lengths by drawing it through sterile gauze held between the thumb and finger. The threads are now somewhat stiff yet flexible, are easily threaded, never "kink" and slip through the tissues

with the minimum amount of friction and traumatism and do not readily tear out of the tissues in which they are placed. Moreover, knots made in these threads are much less likely to irritate and abrade the cornea or bulbar conjunctiva. Once introduced through the lower wound margin they should be allowed to hang down over the globe (see the figure) and to rest on a sterilized towel placed on the cheek. After the sutures have been thus placed the bulbar conjunctiva should

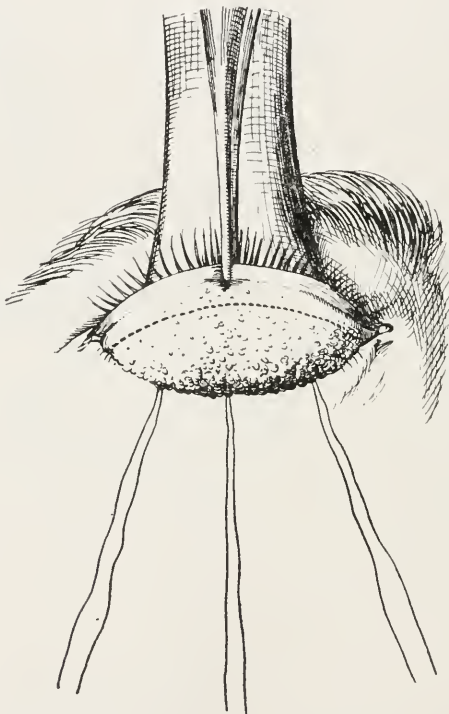


Excision of the Tarsus in Trachoma.

Second act. Complete Eversion of the Upper Lid and Exposure of the Retro-tarsal Folds. First incision along the dotted lines. (Kuhnt.)

be separated from the globe a distance of 3 to 5 mm. from the edge of the wound. The forceps may now be removed from the convex border of the tarsus and the lid margin grasped at its middle point, a horn spatula being passed behind the everted lid, as shown in the diagram. A second incision, running the whole length of and parallel to the lid edge, is now made as nearly as possible in the healthy conjunctiva. Sometimes this will be three, sometimes even five mm. from the palpebral border, the intention being to remove as little of the unaffected mucous membrane as possible and so to leave as large a portion of the central conjunctival area as is consistent with the needs of the

case. The spatula may now be removed, the assistant drawing the lid upward and backward with one or two fixation forceps. The operator then seizes the tissues at the nasal junction of the two incisions and with scalpel and scissors slowly excises conjunctiva and tarsus, carefully avoiding the orbicularis and Mueller's muscle. At this point the anesthetic may be removed, and some time allowed for the bleeding to cease. There should not be much trouble with hemorrhage,



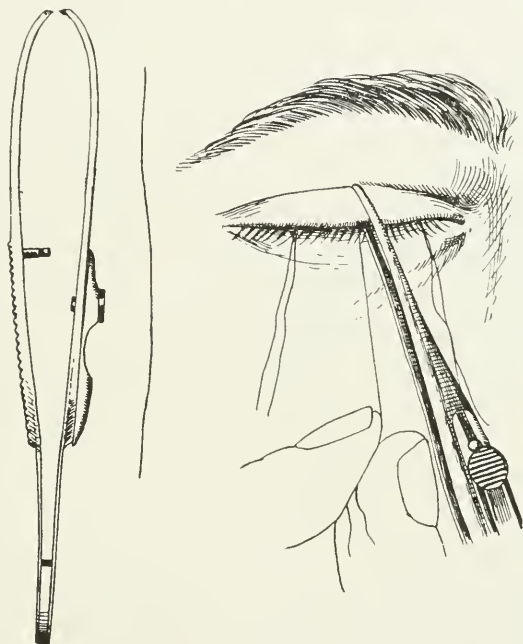
Excision of the Tarsus in Trachoma.

Third act. Second incision near the lid margin, after placing of the sutures in the upper border of the first wound. (Kuhnt.)

although a few small branches of the arterial supply may have to be twisted.

The conjunctival sac should be thoroughly irrigated and the lips of the wound brought together. To secure a satisfactory result one must be particular to place each suture in both wound margins so that it will exactly oppose its fellow when the eye is closed. It is also requisite that the bulbar conjunctiva should not be too much put upon the stretch. The middle suture should first of all be tied with a single

knot and it is wise to make certain, by closing the lid, to ascertain whether the precaution just mentioned has been taken before the final knot is tied. The operator should allow the patient to recover from the anesthetic sufficiently to enable him to determine accurately whether the palpebral movements are sufficient and to be sure that there is no irregularity visible at the lid margins. If the interpalpebral space is the same, both with the eye open and shut, as it is on the



Excision of the Tarsus in Trachoma.

Fourth act. Bringing the edge of the wound together after tarsal excision.
 Estimating the proper place to enter the needles below. Forceps
 used in operation. (Kuhnt.)

opposite side, and if the lid margins have a regular outline, all is well and the threads may be cut off close to the knots.

As a rule there is little subsequent pain, and very little reaction. The after-treatment is simple and need not interfere with the attention properly demanded by the presence of corneal ulcer or other complications. On the whole gentle irrigation of the sac four or five times daily with warm boric acid solution, followed by the instillation of warmed and sterile vaseline, is grateful to the patient and acts very nicely. The vaseline keeps the sutures soft and serves to protect the cornea.

Apply a light bandage over both eyes and order the patient to keep quiet, but do not insist upon his remaining in bed. The sutures are removed on the fourth or fifth day. In a week or ten days the wound is usually quite healed but the sac should be subsequently examined for the presence of granulation tissue or irregular wound margins. These are best clipped off or trimmed with scissors.

The indications for the combined operation are: (1) Long standing cases in which the lids show trachomatous infiltration, with granulation deposits in the connective tissue of the retrotarsal folds, whether the cornea be affected or not. (Wood.) (2) Thickening and enlargement of the tarsus. (3) Disease of the folds with corneal complications but without involvement of the tarsus. (4) Deep-seated foci in the tarsus remaining after the cure of granulations in the tarsal folds.

The contra-indications are: (1) Recent cases. (2) Cases which promise definite cure by less radical measures. (3) Cicatricial cases. (4) Cases with a tendency to xerosis of the conjunctiva.

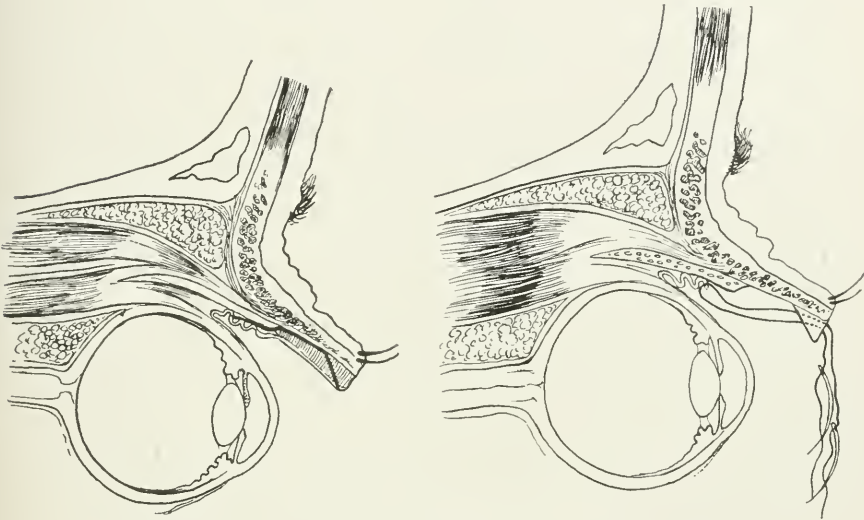
Modifications of combined excision. One of the most difficult features of the operation is the proper placing of the sutures. To facilitate this step slight modifications have been proposed.

Falta inserts each suture in the upper wound margin, as soon as the dissection of the tarsus has reached a point opposite the site of the suture in the lower wound margin, thus getting his sutures in position before the anatomical relations are disturbed. After tying, the stitches are left with long ends and are affixed by adhesive tape to the temples. On the fourth days the stitches are gently pulled out without everting the lids. To avoid abrasion of the cornea by sutures and to prevent entropion, Cahn (*Centralb. für Prakt. Augenheilk.*, p. 369, Dec., 1898) passes doubly armed sutures through the lid, and ties them on the skin surface. Gronbähn (*Tidskrift för den Nordske lægeforming*, p. 829, 1907) inserts a continuous suture and ties it on the skin over a roll of cotton.

Blascovics (*Zeitschr. für Augenheilk.*, May, 1906, p. 391) introduces doubly armed sutures upon the inner surface of the lid above the incision, passes them through the thickness of the lid emerging on the skin surface and ties.

Beard (*Ophthalmic Surgery*, p. 365, 1910) has suggested a number of modifications. He makes the incision in the tarsus slanting upward instead of perpendicular to the plane of that body, thus securing "less unevenness in the resulting cicatrix." To avoid contact of the knots of the middle sutures with the cornea, five double-armed sutures are introduced as follows: One needle passes through the flap of conjunctiva from the epithelial side, then through the remnant of tarsus,

coming out at the free border almost in line with the cilia. The other needle is made to pass through the tarsus in a similar manner, but slightly in front and to one side of the track of the first needle. The two ends of thread are tied over a long, slender cylinder of gauze. The two outer sutures are knotted in the usual way, i. e., on the conjunctival surface. Addario (*Arch. di Ottalm.*, July, 1908) removes the upper two-thirds of the tarsal mucosa, and upper third of the tarsus and transplants healthy conjunctiva from the eyeball to fill the gap.



Modifications of Combined Excision in Trachoma. (Beard.)

Bitzos (*Jahr. f. Ophthalm.*, p. 402, 1899) excises the diseased part of the tarsus, scarifies the posterior surface and transplants it with the posterior surface turned to the front.

Various objections to these operations have been advanced largely on theoretical considerations. It has been contended that contraction of the conjunctiva, the usual sequel of a trachoma that has run its course, would be promoted. It is true that irregular folds in the region of the sulci, limiting ocular excursions, have been observed, but only when sutures have been improperly placed. The possibility of ptosis from destruction of the levator nerve endings has also been urged as an objection. As matter of fact, owing to relief from spasm of the orbicularis, the palpebral aperture is appreciably wider after the operation. The removal of much of the incurving tarsus has a decided tendency to restore the lid margin to its normal position. En-

trypion, therefore, need not be feared. It is possible that corneal ulcers may have occurred through rubbing of the sutures. This is a danger that can be readily avoided by modified suturing as described above.

The most important result of this operation is the relief given to the irritative symptoms of the disease. Very shortly after the removal of the stitches we notice the subsidence of the photophobia, the lachrymation, the foreign body sensations, and the local discomfort that accompany chronic granular lids, even when there is no ulceration of the cornea or no acute conjunctivitis present. Pannus is always lessened and may even disappear, and as a direct consequence of this, the sight is much improved. In one very severe case of corneal infiltration, referred to in previous communications, where the visual acuity had fallen to 1/10 it rose to 2/7 within three months after the tarsal excision. The asthenopia generally exhibited in the better eye of a case of chronic unilateral trachoma is wonderfully improved, and, strange to say, in not a few cases those common sequels of chronic trachoma, entropion and trichiasis, are decidedly less marked than before the operation. Finally, when we have to deal with recurrent ulcer of the cornea, a cure of the abnormal conditions behind it generally prevents a return of the disease. (Casey Wood.)

The combined excision is, in Kuhnt's estimation, the best prophylactic against pannus.

Extirpation of the tarsus without sacrifice of the conjunctiva. This operation was devised by Kuhnt for cicatricial cases in which the conjunctiva was free from disease and overlay a thickened, infiltrated tarsus. Such cases are very prone to develop pannus and mechanical ptosis. The extirpation of incurved tarsi has also been found efficient as a relief from entropion.

The operation is thus described by Beard (*Oph. Surgery*, p. 367):—

An assistant grasps the margin of the lid with the Blomer forceps, everts it, and places beneath the now inverted tarsus the Jäger spatula. The operator makes an incision through, and the whole length of the tarsus, $2\frac{1}{2}$ mm. from the free border, taking care not to wound the fascia underlying the orbicularis. The conjunctiva is dissected from the tarsus, leaving the latter exposed. The cartilage is then separated from the pretarsal connective tissue up to the convex border by means of blunt-pointed scissors, and, lastly, it is detached from the levator tendon. As a rule, sutures are not required. The after-treatment is the same as for the combined excision.—(J. G. Jr.)

Howard F. Hansell (*Trans. Coll. of Phys., Phila.*, Mar. 20, 1913) found that *after tarsectomy* there is usually marked improvement of

vision. The corneæ become clear through the absorption of some of the exudate and by the disappearance of much of the vascularity. The photophobia, lachrymation, and pain, which had been prominent symptoms, were entirely relieved in two cases reported.

Hansell's operation consists in a separation of the posterior layer of the conjunctiva, which in most cases must include at least the anterior part of the superior fornix, from the tarsus. The conjunctiva is loosely attached and easily stripped off, showing the glistening, yellow surface of the distorted tarsus. The incision is made horizontally along the posterior or upper border of the tarsus. The tarsus, having been freed from the conjunctiva above and from the orbicularis and skin, is, with the attached palpebral conjunctiva, cut away at or near its ciliary border. No sutures are used. The lower cut edge of the conjunctiva becomes attached to the lid. The reaction is insignificant. After recovery the lid, aside from being much softer, appears but little changed from its previous condition.

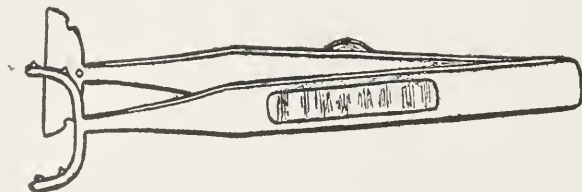
Zentmayer performed total excision of the tarsus and resection of the conjunctiva for a very severe luxuriant type of trachoma. The result was perfect, as the eyes remained entirely free from irritation and vision was almost normal. Instead of a slight ptosis, as one might expect from the removal of the principal attachment of the levator, there was for a time a retraction of the upper lids.

H. W. Wooton and L. W. Crigler (*Journ. Am. Med. Assocn.*, Mar. 30, 1912) have favorably reported on *tarsectomy in cicatricial trachoma* in over a hundred patients in the Manhattan Eye and Ear Infirmary. Although careful histories were not recorded yet relief and cure resulted in seventy-five per cent. of these cases.

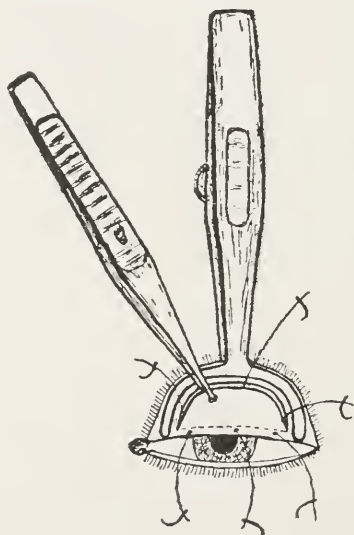
A modification of the Heisrath *tarsectomy* is reported by J. H. Claiborne (*Archives of Ophthalm.*, March, 1912). He finds it applicable to all cases of trachoma in which cicatrization has commenced and pannus and keratitis are present. The writer describes and illustrates a lid clamp (see the figures) which he has devised, and states that his operation differs from the Kuhnt-Heisrath method as follows: 1. It is practically bloodless. 2. It can be performed in ten or fifteen minutes. 3. The extent of the incision is outlined by the curve of the forks of the clamp. 4. The line of the sutures is not at right angles to, but is parallel with, the border of the lids. 5. The central sutures are set farther from the ciliary region than in the other operation: in this way the tucking of the lid in the center is avoided and a deeper fornix insured. 6. The hands of the operator alone are around the eye.

Kuhnt (*Zeitschr. für Augenheilk.*, Dec., 1913) very properly insists that one should *treat individual cases* according to the stage and nature of the disease, and to the social status of the patient. He lays

down the following rules: (1) Early cases should be treated by local applications. In the presence of secretion, silver nitrate solutions are indicated, followed up by preparations of copper sulphate. (2) If the disease advances, the granules may be destroyed by the galvano-cautery, at the same time continuing the treatment with copper sul-



A New Clamp for the Excision of the Tarsus and Conjunctiva. (Claiborne.)



Operation for the Excision of the Tarsus and Conjunctiva with the Aid of a Special Clamp. (Claiborne.)

phate. Massage and brossage may be helpful, and light treatment may be advantageous (X-rays, Finsen light, and radium). (3) In the stage of fleshy softening, "expression" is necessary, and the local treatment with caustics must be continued. (4) In infected regions in early cases, local treatment with caustics (silver salts and copper sulphate) is indicated. (5) If no result is noted and complications threaten, excision of the infected conjunctiva yields the best results. (6) In the cicatricial stages no removal of conjunctiva is allowable.

It is best to excise the tarsus. (7) Excision of the tarsus and of the infected conjunctiva is the best means of preventing pannus and of curing existing pannus. (8) No bad effects are seen after correctly performed surgical operations. They cure trachoma in a few weeks and generally permanently. Kuhnt objects to the use of such instruments as the Graddy and Knapp forceps. They tear the conjunctiva and bruise the tissues, and so increase the tendency to cicatricial contraction. He claims that his "expressor" of two blades, one of which is perforated, is more efficient. Simple expression, with no dragging along the lids, is possible with this instrument.

The experience of Addario La Ferla has been that the operation of tarsoconjunctival excision is useful in bad cases in the proliferative stage with marked thickening of the tarsal and pretarsal mucosa, and in cases with coexisting pannus siccus, and in those with a notable degree of ptosis from trachoma. It is contra-indicated in acute and subacute trachoma. It does not tend to produce entropion.

Arntz (*Prac. Med. Series, Eye*, 1914) says that the *placing of the sutures in extirpation of the tarsus* according to the regulation method is most important. From an experience of 147 cases he is convinced that extirpation of the tarsus is the most practical way of overcoming entropion. Also in the corneal complications good results are secured, but it should not be performed for this sequel until all other therapeutic measures have failed. Dean prefers to operate from the skin surface, and excising all of the tarsus down to within 3 mm. of the lid margin.

W. E. S. Moncrieff (*Indian Med. Gazette*, 51, No. 8, 1918) gives as his experience of the treatment of trachoma that astringents, caustics and resorbents are hopelessly inadequate; and he has gathered rather damning evidence as regards caustics and copper. Carbon dioxide snow has been tried and found to be no more efficacious than caustics. Few cases are suitable for expression and grattage. Subconjunctival injections are disappointing. Excision of the conjunctival fornix has been done only a few times.

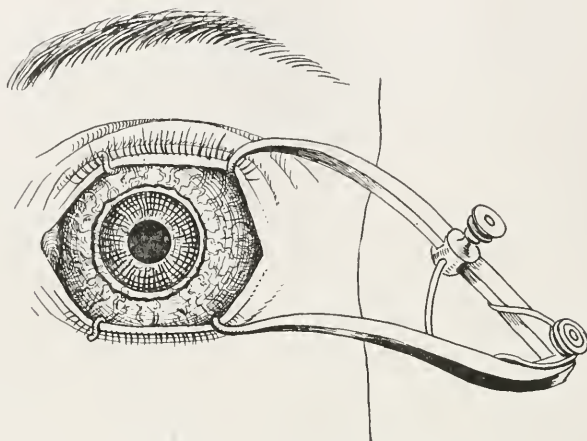
Tarsectomy is effective and he notes that as a result of the operation, the lid does not lose its shape. On the contrary in advanced cases, its shape is improved and the levator muscle can still exercise its function.

Operations for the relief of Pannus.

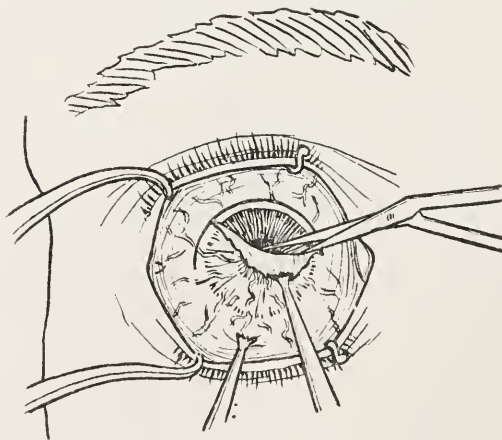
These are described under **Pannus**, p. 9222; **Peritomy**, p. 9613, and **Peridectomy**, p. 9416, Vol. XII of this *Encyclopedia*. See, also, the illustration of *peritomy* in this text.

Additional observations on the surgical treatment of pannus are as follows.

Pannus dissection is recommended by Dickson (1911) for thick vascular pannus remaining after the lids have been rendered comparative-



Peritomy for the Relief of Pannus.



Dickson's Operation of Dissection of Trachomatous Pannus from the Cornea.

ly smooth. After use of cocain with an adrenalin preparation, he divides the conjunctiva 3 to 5 mm. back from the corneal margin as though for peritomy. The vascular tissue is carefully dissected up from the sclera and true corneal tissue, a special effort being made to include all the vessels. The separated tissue is held and rolled over by a broad

forceps that will not readily tear it, and the dissection made with iris scissors. See the figure. Where the corneal ulcers have left scars the dissection is carried around them, and the parts afterward trimmed smooth with a cataract knife. The thicker and more vascular the pannus the easier the dissection. One case is reported in which the patient came to have the eye removed. The pannus completely covered the cornea, and hid the iris and pupil. Treatment of the trachoma and dissection of the pannus gave vision of 6/12.

Kaz (*Actes du XII Congrès Internat. d'Ophthalmol.*, Petrograd, 1914) inserts in cases of *trachomatous pannus* a thin transparent film of celluloid (0.1 to 0.03 mm. thick), in the form of a shell, covering, and in close contact with, the cornea. In this way the surface is kept moist and becomes more transparent. Vision is improved, the celluloid film is well tolerated, and the results are reported satisfactory.

Detachment of the bulbar conjunctiva. Modifications of *tarsotomy with something in common with the old operation of peritomy for pannus*, is reported by Kazuo Hiwatari (*Amer. Jour. Ophthalm.*, March, 1919). After disinfection of the eyelids and the conjunctiva, 0.5 or 1.0 ccm. of 1 per cent. cocaine solution are injected subconjunctivally at the fornix or under the bulbar conjunctiva close to the latter. Then a flat incision is made by means of a thin and sharp knife parallel with the upper margin of the tarsus from the inner to the outer canthus, through the fornix or the bulbar conjunctiva.

Three sutures are introduced through the lower lip of the conjunctival wound, in the form of loops and given to an assistant, who helps the further detaching of the bulbar conjunctiva from the underlying tissue, by moderate traction on them.

The detachment of the conjunctiva bulbi toward the cornea is usually achieved very easily and with less bleeding by the help of Graefe's linear knife. The detaching must extend also toward the median and lateral sides of the cornea, if the blood-vessels run into the pannus from those sides.

The wound in the conjunctiva is sutured continuously toward the inner and outer canthi by means of the middle loop. Fixation of each end of the suture thread on the skin of the inner and outer canthus is made with adhesive plaster, and a bandage.

As after-treatment daily irrigation of the cul-de-sac with a weak disinfecting solution is recommended. If much reaction occurs, instillation of atropin is required. The suture is removed after four days.

If necessary, measures must be continued for the trachomatous changes in the conjunctiva and fornix, after complete healing of the wounds.

Twenty cases of trachomatous pannus in thirteen patients had been treated in this way by the writer, and had been observed long enough to determine the effect of the operation.

The blood-vessels in pannus diminished gradually in all cases after this procedure, and in the cases in which one or one-half year had already elapsed they could not be found even by means of a loupe. More or less corneal opacity in irregular form remained as a result of the pannus.

Vaccinotherapy of trachoma. Demaria, Mazza and Rebay (*Boletin de la Sociedad de Oftalmologia de Buenos Aires*, third year, p. 68; abst. *Am. Journ. of Ophthalm.*, p. 606, 1916) describe their method. In two tubes containing two cubic centimeters of sterile physiologic solution and a number of glass pearls are placed as large a number as possible of trachomatous follicles extirpated by superficial and deep curettement of the conjunctiva. This mixture is agitated for one hour, the pearls mechanically triturating the follicles. Sulphuric ether is added in quantity equal to that of the physiologic solution, the resulting mixture being agitated for twenty-four hours. The sterility of the mixture being tested by cultures on agar, the ether is evaporated, the remaining liquid is diluted ten times and filtered through sterile paper, and is placed in sterile sealed ampoules. A dose of one cubic centimeter of this preparation, either as an auto-genous or heterogenous vaccin, was injected subconjunctivally. The result was a slight reddening of the palpebral conjunctiva and a flattening of the granulations. The redness disappeared in a short time and the flattening of the granulations increased. Twenty cases were thus treated, most of them having a marked pannus and ulcers of the cornea. The number of injections administered varied from three to seven, always at intervals of one week. In the majority of the cases a marked improvement resulted from the treatment.

SUMMARY OF TRACHOMA TREATMENT.

Expression of the trachoma bodies is indicated when the follicles begin to show softening, i. e., at the beginning of the second stage. At this period expression is the operation of choice. It is contra-indicated in acute trachoma, in cases of follicle formation in the transition fold, during an acute exacerbation and in the cicatricial stage.

Grattage may be used in much the same period and is especially useful when there is much hyperplastic material in the conjunctiva. The method devised by Jameson is useful as an adjuvant to expression.

Coover's sandpaper grattage is applicable to all forms of trachoma.

Even in the old cicatricial stages it acts beneficially, smoothing down the rough and hypertrophied portions of the membrane.

Sattler's operation is available in all cases with evident follicular deposits. Chronic cases with thickened lids should be subjected to preliminary medical treatment until the follicles become visible when they should be punctured and eurented. In practice this method has been largely reserved for cases in which the granulations are isolated and few.

For the obliteration of clumps of little follicles, which are found on the convex tarsal border of the upper lid, and for smoothing out papillary overgrowths on the tarsal conjunctiva, Falta's operation with a dental burr will be found useful.

Massage, either simple or medicamentous, is applicable during the second stage. The unquestioned efficacy of the method is dependent on depletion of the engorged conjunctiva and the smoothing of the roughened surface by repeated abrasions. Doubtless, too, activity of the lymphatics is increased by the mechanical stimulation.

Brossage is indicated whenever the voluminous granulations occupy the cul-de-sac and when the infiltrated conjunctiva is being converted into waxy tissue. Too energetic brushing may result in partial destruction of the conjunctiva and subsequent entropion.

Galvano-cauterism with fine electrodes may, if cautiously employed, be used to eradicate isolated granulations.

Electrolysis after preliminary scarification (Lindsay-Johnson's operation) is useful in chronic trachoma of either the papillary or follicular variety before cicatricial changes have set in.

Simple electrolysis is of only limited applicability.

The X-ray has hardly justified the enthusiasm of the earlier experimenters with this method. Some cures have undoubtedly been effected but the majority of cases, even after prolonged radiation, still exhibit granulations.

Radium has undoubted therapeutic value in recent cases. It is useless in the cicatricial stage.

Simple excision of a strip of infiltrated fornix is of value when the tarsus and bulbar conjunctiva are becoming involved, when corneal ulcers appear, and to guard against recurrences.

Combined excision is indicated in long standing cases, in which the lids show trachomatous infiltration and granulation deposits in the connective tissue of the retrotarsal folds; when the tarsus is thickened and enlarged; when the folds and cornea are diseased but without involvement of the tarsus; and when there are deep-seated foci in the tarsus remaining after the cure of granulations in the tarsal folds.

The operation is contra-indicated in cases which show a tendency to xerosis.

Extirpation of the tarsus may be performed in cicatricial cases when the conjunctiva is free from disease and overlays a thickened, infiltrated tarsus, in which are located the majority—perhaps the only remaining trachoma bodies. It may also be employed to remedy moderate entropion.

Subconjunctival injections may have a certain value, especially when associated with other procedures, such as scarification, curettage, etc.

Auxiliary measures, e. g., the removal of pterygia, canthotomy, forcible stretching of the lids, and excision of skin and muscle from the upper lid may be of benefit in selected cases.

Pertinacious vascularity of the cornea is often greatly diminished or even eradicated by peritomy or peridectomy.

Trachoma, Bacteriology of. See **Conjunctivitis, Trachomatous, Bacteriology of.**

Trachoma bodies. See **Trachoma.**

Trachoma carunculorum. An old term for a so-called variety of trachoma in which fleshy excrescences are met with in the conjunctiva.

Trachoma herpeticum. An old term for that form of the disease in which pustules or vesicles are found on the inner surface of the eyelids.

Trachoma mixtum. Granular conjunctivitis with secondary inflammation of the surrounding tissue.

Trachoma sabulosum. An old term for trachoma, so called from the sensation as of sand beneath the lids.

Trachoma treatment. See **Terminol.**

Traction company employees, Examination of the eyes of. See **Eyes of soldiers, sailors, railway and other employees, Examination of the.**

Traction string. E. E. Maddox (*Trans. Ophthalm. Soc. U. K.*, Vol. 34, 1914: abs. *Ophthalmoscope*, p. 34, Jan., 1915) has employed what he describes as a "traction string" to enable the wound toilet, in intracapsular cataract extraction, to be made in the open instead of under the tent-like upper lid. After the introduction of the speculum, "a linen thread was passed horizontally through 3 or 4 millimetres of episcleral tissue at the insertion of the superior rectus tendon: its two ends were then placed together over the temple, so as to be out of the way, and not interfere with the removal of the speculum later. After the extraction of the encapsuled lens, the eye was drawn down

just sufficiently by the string to allow the toilet to be effected in full view without the slightest tendency to open the wound." Maddox shows by a diagram how the pull must be made parallel with the belly of the rectus. If the pull be at a higher angle the wound tends to gape. If at a lower angle there is a tendency to raise the intra-ocular pressure. As soon as the operation is completed, the suture is withdrawn after cutting one of its two halves close to the eyelashes.

Tracts, Ophthalmic. Optic tracts. The continuation of the optic nerves from the commissure backward to the brain. See **Intracranial organs**, p. 6547, Vol. IX of this *Encyclopedia*.

Tragacanth. GUM TRAGACANTH. GOAT'S THORN. HOG GUM. This agent is a gum from a number of species of *Astragalus*. It is found as whitish, brittle, translucent, ribbon-shaped bands of a horny consistency; forms a cloudy, jelly-like mass in 50 parts of water; mostly composed of starch, bassorin and peetin. In ophthalmic practice it is usually employed for protecting the skin about the eyes, for the treatment of fissures at the angles of the lids in sealy and moist eczema of the latter, and as a vehicle for powders and salves. For these purposes Wolffberg recommends the following formula: Tragacanth, 5.0; Glycerin, 2.0; Aquæ dest. ad., 100.0.

The Editor heartily endorses this simple mixture for the purposes mentioned and believes anyone using it will be pleased with the result.

In ancient Greco-Roman times, gum tragacanth was almost universally employed as a menstruum in the ophthalmic materia medica. It was also used to hold together the various ingredients of the so-called collyria. (See **Ophthalmology, History of**)—(T. H. S.)

Träger. (G.) Holder

Training, Orthoptic. See **Amblyoscope**, as well as **Muscles, Ocular**, and **Stereoscope**.

Training the blind. See **Re-education of the blinded**, p. 10899, Vol. XIV of this *Encyclopedia*.

Walter L. Beasley (*Scientific American*, May 17, 1913) describes the new five-story building erected by the New York Association for the Blind. Not only are facilities provided for instruction along many lines enumerated, but there are thorough arrangements provided for physical training and recreation. The New York Association for the Blind is supported entirely by voluntary contributions and has accomplished much useful work for the blind, including the placing of blind children in the public schools, of which there are now 160 in attendance.

Tränenapparat. (G.) Lachrymal apparatus.

Tränendrüse. Lachrymal glands.

Tränenröhrchen. (G.) Canaliculi.

Transactions of ophthalmic societies. See *Journals* under **Ophthalmology, Literature of**, p. 8912, Vol. XII of this *Encyclopedia*.

Transcallosal puncture. An operation for the relief of choked disc.

See Vol. III, p. 2097, of this *Encyclopedia*, also **Puncture, Callosal**.

Transection. CROSS-SECTION. A section at right angles to the principal axis.

Transferred ophthalmitis. The term transferred ophthalmitis for the so-called "sympathetic irritation" and "sympathetic ophthalmia," which are simply different stages of the same condition, is preferred by Oliver. He believes that the expression "sympathetic," as ordinarily understood in this connection, has no significance and bearing whatever and is certain that the term "irritation" is just as false; he is also sure that it must be conceded that the word "ophthalmia" should not be applied to any form of inflammation of the interior of the eyeball. The word "transferred" is correct, no matter what the process may be, and the generic term "ophthalmitis" is both adequate and comprehensive. See **Sympathetic ophthalmia**.

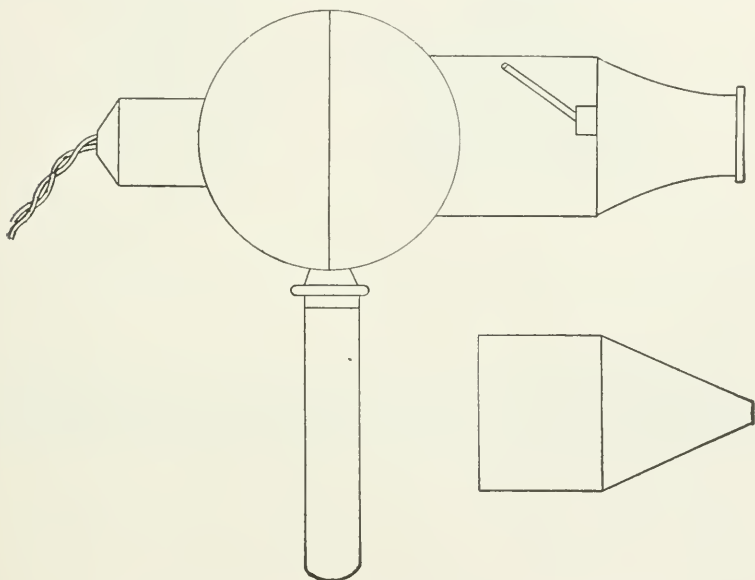
Transfixion of the iris. TRANSFIXIO IRIDIS (FUCHS). In cases of *iris bombé* (see p. 497, Vol. I of this *Encyclopedia*) excellent results follow the passage of a thin knife through the cornea and bulging iris. The incision re-establishes communication between the anterior and posterior chambers, while the opening forms an artificial pupil.

See, also, **Glaucoma**, p. 5543, Vol. VII of this *Encyclopedia*.

Transgression. This is a term suggested by Morgenroth and Ginsberg (*Oph. Year-Book*, p. 35, 1913) who found that the variation as regards promptness and duration of anesthesia, which exists between watery solutions of the salts of the alkaloids, was not nearly so pronounced between the simple alkaloids in oily solution. Furthermore, although the alkaloids are much less soluble in water than their salts, yet the anesthesia produced by the oily solutions of the alkaloids did not apparently compare unfavorably as regards promptness and duration with that obtainable from the watery solutions of the salts. The authors assume that there is a continuous flow of the alkaloid from the oily solution through the thin layer of lachrymal secretion which must lie between the oil and the cornea, this process being probably favored by the formation of a micro-emulsion at the junction of water and oil; and that the third phase of solution of the alkaloid is in the corneal epithelium. The peculiarity of this process, for which the authors propose the term "transgression," consists in the presumable fact that a dissolved substance passes from the first phase (the oily

solution) to the third phase (anesthesia of the epithelium) without a concentration such as would be adequate for anesthesia taking place during the intervening phase. Some experiments with washed red corpuscles from the goat yielded the result that, when a certain amount of hydrochlorid of ethylhydreocuprein had been added to a watery suspension of the red cells, the corpuscular sediment acquired anesthetic properties (as determined on the rabbit's eye) which was lacking in the fluid which had contained them. The behavior of the blood-corpuscles and the containing fluid parallels that of the corneal epithelium in the presence of the oily alkaloid solution with its intervening cushion of lachrymal secretion.

Transillumination. DIAPHANOSCOPY. DISCLERAL OR TRANSLERAL ILLUMINATION. This important subject has already been thor-



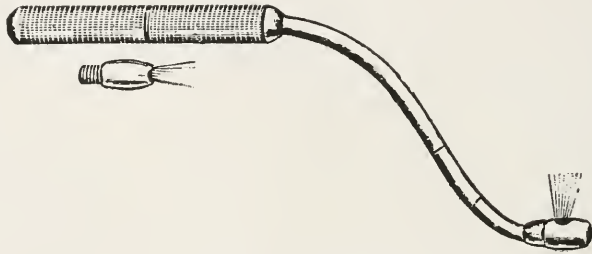
Combined Hand Operation Lamp and Transilluminator.

oughly discussed and illustrated under **Diaphanoscopy**, on p. 3938, Vol. V of this *Encyclopedia*. To that material is here appended additional information regarding chiefly new transilluminators.

A *combined operating hand-lamp and transilluminator* is depicted in this text. It gives a disc of illumination with a diameter one half the working distance. Other relative values of working distance and disc diameter can be made if required for special purposes. The source of illumination is an 8-volt Osram lamp of 32 candle power.

For special work a 4-volt lamp with a self-contained dry battery is used. The size is 8 in. long over all; it is $2\frac{1}{2}$ in. diameter, and the weight is 10 ounces.

Allen Greenwood (*Trans. Am. Ophthalm. Soc.*, 1913) proves the utility of the modified transilluminator devised by Walter Lancaster. See p. 3944, Vol. V of this *Encyclopedia*. See, also, the cut in this text. Greenwood's patient was a lady, aged 31 years, whose right eye was in a state of absolute glaucoma. A faint reflex only could be obtained with the ophthalmoscope, owing to the cloudiness of the media. The ordinary transilluminator showed a dull-red reflex everywhere, even when pushed as far back as possible. Eserin and pilocarpin failing to afford relief, iridectomy was performed. A week later ophthalmoscopic examination was possible, and revealed a de-

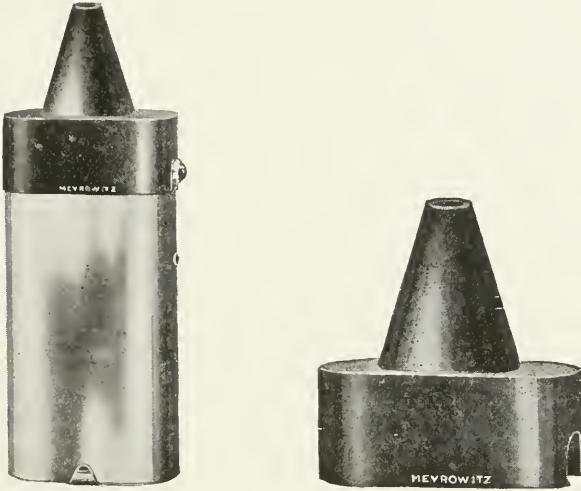


Lancaster's Posterior Ocular Transilluminator.

tachment of the retina covering the optic disc, and extending downward and forward. Transillumination again showed nothing. The eye was removed. On testing the enucleated globe with Lancaster's illuminator and pressing the point of the latter to the back of the eye, close up to the exit of the nerve, an entire loss of light transmission could be observed, which was restored if the appliance was moved more than 4 mm. from any side of the nerve. See the illustration.

Holbrook Lowell (*Ophthalmic Record*, March, 1911, p. 124) pictures a simple, efficient, inexpensive and easily portable device. Besides its value in transilluminating the eyeball it is useful in dissections and similar ophthalmic operations. It is really a flash-light with a tungsten lamp of considerable power. See the figure. The cap attachment is made of copper, or any other suitable material. The interior of the tube is silver-plated, and the whole exterior of the attachment is painted a dull black. The tube flares from the circumference of the lamp, being 21 mm. high to the opening, which is 5.5 mm. inside diameter. The slot at one end of the cap admits the switch button of the lamp, but

by reversing the cap the button may be kept pressed down, thus closing the switch and giving a steady light. No magnifying glass, or glass rod is used, as the light and reflection from the silvered surface gives



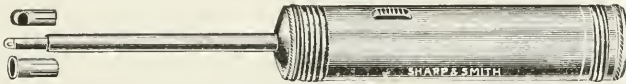
Ocular Transilluminator. (Lowell.)

ample illumination. There is no heat generated even after protracted use. The light pencil is solid, with no reflection of the luminous wires.



Maijgren's Ocular Transilluminator.

Maijgren's ocular transilluminator needs no description. See the figure.



Reeder's Transilluminator.

Reeder's transilluminator is described in the *Journ. Am. Med. Assocn.*, p. 1385, Apr. 29, 1916. It consists of a small, dry-cell battery mounted in a case similar to an ordinary flashlight, which has a small but powerful lamp mounted at the free end of a rodlike projection

and protected by removable caps, one fenestrated at the side, the other at the end.

It may be used not only for purely ophthalmic purposes but in exploring the neighboring cavities as well. See the figure.

Transit. A surveying instrument for the approximate measurement of horizontal angles.

Transit-circle. An astronomical telescope adjustable in the plane of the meridian.

Transit instrument. An astronomical instrument for determining the times of the transits of celestial bodies across the meridian.

Translucent. TRANSLUCID. Transmitting light, but not transparent.

Transmission of infection through the eye. Capt. K. F. Maxey (*Jour. Amer. Med. Ass'n.*, March 1, 1919) remarks that the eye has received slight attention as a factor in the transmission of acute respiratory infections. It has been disregarded in planning measures for the prevention of the spread of contagious diseases. This was especially true in the recent epidemics of influenza. No provision has, for example, been made in the ward routine of contagious hospitals for the protection of the eye of healthy persons in attendance on the unmasked sick.

It has long been known that large numbers of various organisms, including the pneumococcus, streptococcus, influenza bacillus, and many others, may be recovered from the conjunctival sac, especially if there is obstruction to the overflow of tears. The conjunctival sac is never sterile. The source of contamination has been attributed largely to the impingement on the conjunctiva of the eyeball and the cornea of dust particles bearing microorganisms. It is evident that droplets sprayed from the mouths of other persons during the act of talking, laughing, coughing, sneezing, etc., must be another frequent source.

Infections are most likely to be transmitted during the waking hours when a person has his widest range of activity, and is coming into intimate association with numbers of other human beings. This is especially true in crowds, in which the range for droplet spray is short. Under these conditions the mouth is closed a large part of the time, in particular when another (perhaps infected) person is talking to (spraying) the noninfected healthy person who assumes the attitude of a listener. With the mouth closed, only the lips may receive the droplets; the bacteria dry there and perish, or perhaps they are swept into the mouth by movements of the tongue. Furthermore, when a healthy person is talking, air currents are created that are

adverse to the entrance of droplets from the infected. The mouth surface exposed to droplet spray may consequently be represented as averaging about 100 sq. mm.

The nares at such times may not be directly exposed, owing to the protected anatomic position when the head is slightly inclined forward. With every expiration, adverse air currents are created. Hence, although a cross-section of the nares gives an area of about 200 sq. mm., this is available for direct droplet spray less than half of the time.

Contrasted to these areas, some 600 sq. mm. of eye surface area are constantly exposed to droplet spray during the waking hours, except for the very brief intervals during the act of winking, an act which is in itself of significance for the mechanism, as is well-known. Certainly the chances of infecting the eye are fully as good as those of infecting the nose and mouth, if not better.

After a number of experiments intended to settle the question of infective transmission by the ocular apparatus Maxey concludes:

The eyes offer a relatively large surface area for the reception of droplets sprayed from the mouths of other persons.

An organism introduced into the conjunctival sac may be recovered from the nose in five minutes, from the throat in fifteen minutes, and from the stool in twenty-four hours.

The upper respiratory tract of a person wearing a properly constructed mask may be infected by exposing the eye briefly to direct droplet spray.

This portal of entry is of importance in the transmission of acute respiratory infections.

Transmission of radiant energy by various ophthalmic glasses and ocular media. All about us energy is constantly being transferred from one place to another. When this occurs something is moving and something is being moved through, hence there must be a medium of transmission. Radiation is a form or kind of energy and therefore can be produced from other forms of energy and can be converted into other kinds. Heat energy is a convenient form for the production of radiation. For instance, the resistance offered by the filament of an incandescent lamp to the flow of electric current produces energy which is radiated out as disturbances in the ether. These disturbances, having varying wavelengths, are characterized as heat and infra-red, visible, or ultra-violet light when they are intercepted and received by a suitable body. Heat, for example, is not radiant energy but exists only when it ceases to be radiation. And again, radiations of the proper wavelengths, when received by

the eye, cease to exist as radiant energy and become what is popularly spoken of as light.

Nature and Distribution of Radiant Energy.

Light is physically defined as a periodic or rhythmic electromagnetic disturbance in a transmitting medium, the ether, traveling in the form of transverse waves with a velocity of approximately 186,000 miles per second. At first glance it is not evident that there is any connection between light and electricity (or electric waves). Such a relation was predicted mathematically by Maxwell at about 1870. In this theory the assumption was made that light waves are identical with electromagnetic disturbances which are given out from a body in which electrical oscillations are occurring. Hertz later produced these electric waves and the theory of Maxwell was given an experimental verification and the science of wireless telegraphy and telephony was born. The oscillating molecules, atoms and their electrons are presumably responsible for these pulses of electromagnetic energy. While all these radiations travel in free space with the same velocity, they differ considerably in their velocities in ordinary media: in glass, for example, the violet rays travel less rapidly than the red rays. All of these rays carry energy; that is, the rays are the actual physical energy in transmission and hence when absorbed will produce heat, chemical action or physiological change. Sometimes the absorbed radiation is not converted wholly into heat but enters into chemical reaction or is changed into radiant energy of wavelength differing from that of the absorbed energy. Rays shorter than the visible and known as ultra-violet are very active chemically, affect photographic films, destroy bacteria and animal tissues such as the outer membrane (the conjunctiva) of the eye: they also cause phosphorescence and fluorescence. The long wavelengths of the visible spectrum are received by the normal retina and interpreted as representing light and redness of color. Beyond the longest visible red ray (in the region of 7600 Angstroms or tenth-meters) come the infra-red rays. These are commonly spoken of as the heat rays because of the fact that the energy of the radiations is transformed ordinarily in the maximum percentages into heat.

Wavelengths of Light.

The wavelength of light can be measured with extremely high accuracy (*vide* the experiments of Michelson with the interferometer

and so forth) and has been proposed as the absolute standard of length instead of the meter, which was intended to be a ten-millionth part of the earth's quadrant. It is found, however, that different kinds of radiant energy have widely different wavelengths; for example, the different colors (as we may call them) of light, have different wavelengths, red light having the longest and blue the shortest length of the visible region. The wavelength may be specified in units known as the micron (μ), the tenth-meter (t. m.) and the Angstrom (\AA). The micron is the one-millionth part of a meter or the one-thousandth part of a millimeter. The Angstrom unit and the tenth-meter are each equal to one ten-millionth of a millimeter. As a result a radiation, which may be specified as red light, may be defined as 7000 \AA ., 7000 t. m. or 0.7 μ .

Light is, therefore, a form of radiant energy which, when received by the eye, gives normally the sensations of sight and of color. The visible spectrum spans one octave practically. The question as to the sources of these disturbances in the ether leads us to a brief statement of the fact that atoms are now known to be composed of infinitely small particles which are called electrons. These electrons, under given physical conditions, oscillate or vibrate with certain definite periods or frequencies. The number of electrons composing the atom and the rate of frequency of vibration depend upon the element, or the so called atomic number. In order to make that about which we are writing the more tangible, imagine a carbon arc set-up and ready for operation. Before the arc is struck there is no light or heat and no changes in the appearance of the carbon. As the arc is "struck," electric current flows through the carbons and they become incandescent, throwing out heat and light and other forms of energy. By virtue of the disturbances set up in the carbon electrodes under the influence of an electrical potential or pressure, the molecules and atoms of the carbon are agitated: the current passing through the carbon heats it and as the atoms and molecules are thrown into vibration and absorb energy the electrons composing the atom become correspondingly disturbed, vibrating with greater frequencies and by their vibrations and collisions with each other produce disturbances in the ether. These disturbances are propagated into space by wave motion and since the disturbances within the carbon are very complex, a corresponding complex emission of wave energy follows. When the frequency of the waves approaches 400 million millions per second (4×10^{14} cycles per second) a dull red glow appears. When the frequencies of the waves range between 400 and 800 million millions per second (4×10^{14} to 8×10^{14} cycles) the sensa-

tion produced in the eye is that of white or nearly white dependent upon the percentages of the various wavelengths. The range between 400 and 800 million millions represents the visual spectrum between violet (800) and the extreme red (roughly 400). The colors of the so called visible spectrum are as follows:

	Frequency.	Wave-length.
Red.....	400×10^{12} cycles	75×10^{-6} cm.
Orange	460	65
Yellow	508	59
Green	566	53
Blue	652	48
Indigo	710	45
Violet	800	40

It is to be noted at this point, however, that the actual limits of the so-called visual spectrum to the dark adapted eye are not to be set at 0.75μ and 0.4μ respectively.

Spectrum of Radiation.

The spectrum of radiant energy extends from the shortest wavelength known, that of the X-ray having a wavelength of the order of magnitude of 1×10^{-8} cm. (one hundred-millionth part of a centimeter) to the longest waves due to the fields of alternating current circuits and having wavelengths approximating fifteen thousand miles.

Within the past few years methods of crystal spectrometry as devised by Laue and elaborated experimentally by the two Braggs have led to determinations of the wavelengths of X-rays. Shaw has made measurements upon the γ rays given out by radioactive substances and has found them from ten to one hundred times shorter in length than are the hardest Roentgen radiations. Several octaves (an octave representing a doubling of the frequency) are missing between the longest X-ray and the shortest so called ultra-violet wavelength which was set a year or so ago by Lyman, of Harvard, at about 0.06μ or something less than 0.1μ . Just as these words are being penned, however, comes the report that Millikan, of Chicago, has succeeded in getting ultra-violet waves about ten times shorter than the shortest obtained by Lyman. The greater part of the research conducted in this region has been done by means of photography carried on with spectroscopes and specially sensitive plates enclosed in vacuum chambers. Ordinary crown and flint lenses and prisms cannot be used in such experimentation, for they absorb up to wavelength 0.30μ as about the lowest limit. Quartz lenses and prisms are therefore used. In working with the spectrum below 0.185μ such effects as absorp-

tion by the quartz and absorption by the gelatine of the photographic films begin to exert their influence.

The actual division line between the ultra-violet and the visible spectra is commonly and somewhat arbitrarily set at 0.4μ . Doubtless this division point has arisen because of the various determinations of the "visibility curves" of eyes. Hyde, Cady, Forsythe, Hartwell, Nutting, Ives, Reeves, Coblenz and others have investigated these visibility curves with considerable care: something in the neighborhood of 0.4μ in the violet is about the limit of accurate investigation with present experimental photometric devices. These visibility curves are not to be confused with the shortest or longest wavelengths *per se* which a dark-adapted eye can see and measure. Certain data to be presented later indicate the transmission of radiant energy through the ocular media to the retina having wavelengths considerably shorter than 0.4μ . There are doubtless crystalline lenses which absorb all wavelengths shorter than 0.4μ : but Hallauer, for instance, found many who could see as low as 0.36μ to 0.37μ and claims that in the case of youthful lenses there is an actual transmission of rays of wavelength 0.31μ to 0.33μ . At the time these words are being written a careful and detailed experimental investigation is being conducted by the writer and his colleagues upon the lowest limit of radiation visible to a dark-adapted eye. Wavelength 0.34μ (with definite and yet very faint violet color) has been readily observed by several and 0.32μ under proper conditions of intensity. It does not seem logical, therefore, to set the limit of visible radiation as high as 0.4μ . We shall, however, until the weight of evidence is to the contrary, follow the arbitrary division already made, although in certain curves (*vide* Figs. 27-35) we have set the region at about 0.37 to 0.38μ .

The visible spectrum covers about an octave and extends, roughly, from 0.38μ to 0.8μ . It comprises a very small portion of all the known spectrum. The highest sensitivity of the eye is in the yellow-green region at 0.56μ practically. The extreme visible red is at about 0.79μ . Hyde and his collaborators have investigated the "visibility" curves in this region (red end) with considerable thoroughness.

The red end of the spectrum is at the beginning of the ultra-red or infra-red radiations. These rays are often, but improperly, spoken of as heat rays, for they should properly be classed and spoken of in the same manner as are the ultra-violet and the visible. In 1800 Sir William Herschel found that when a thermometer with a blackened bulb was moved into the spectral region just beyond the red, there was a rise in temperature indicated. This proved that there were radiations

beyond the limit of visual sensitiveness. Sir William Abney succeeded in photographing the infra-red spectrum out to $1.1\ \mu$ with specially prepared plates. The late Professor Langley, of fame in these days for his experimentation upon submarines and aeroplanes, constructed an instrument known as a bolometer. In this instrument, based upon the Wheatstone bridge, one arm consists of a fine blackened platinum wire or grid. When this receives radiation it absorbs it and the temperature is raised, the resistance of the wire changed and a current produced in a detecting instrument, a galvanometer. Langley plotted the spectrum to about $61\ \mu$. By the methods of "reststrahlen," interference and focal isolation various experimenters, including such names as Rubens, Hollnagel, Nichols, Trowbridge, and Wood and his co-workers, have succeeded in extending the investigations step by step into the infra-red region to be-

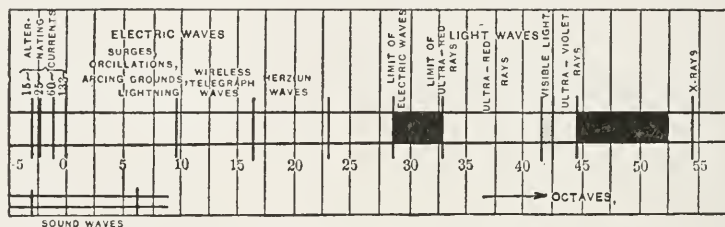


Fig. 1—The spectrum of radiation. (From Steinmetz: *Radiation, Light and Illumination*.)

tween 200 and $300\ \mu$. This corresponds to a wavelength of about 0.2 to 0.3 mm. Rubens and von Baeyer in 1911 found a maximum in the long wave radiation from a quartz mercury arc at $343\ \mu$.

About four octaves gap exists between the longest infra-red radiation as detected by the method of focal isolation and the shortest Hertzian or electric wave thus far found by von Baeyer and having a length of about two millimeters. In passing from one set of radiations to the other we are passing from the region where the *molecule* constitutes the minimum sized vibrator to that in which *molar* relations hold, for electric and Hertzian waves or produced by discharges between electrodes. High frequency currents, surges and oscillations, arcing, wireless, lightning phenomena and so forth, have wavelengths ranging from the limiting wavelength of a fraction of a centimeter as determined by von Baeyer up to $4,000,000,000\ \mu$ in length or, in other words, miles in length. Alternating current fields have cycles varying from 15 to 133. Such figures give us as wavelengths something of the order of 13,000 miles and 1400 miles respectively.

Figure 1 is a graphical reproduction from Steinmetz (*Radiation*,

Light and Illumination, page 18). It is not, at some points, up to date in its representation, but it serves in a very satisfactory manner to graphically illustrate the distribution of radiant energy from alternating currents to X rays.

Radiation and Light Sensation.

The distribution of the energy among the different wavelengths given out by an incandescent solid is shown in Figure 2. This curve is known as a radiation curve and is the envelop of the plotted values of the energy over a great range of wavelengths. A continuous spectrum, in contradistinction to a line spectrum such as is given by a **mercurey arc for example**, is characteristic of the radiation from solid bodies. In the curve of Figure 2, the height of the curve at any point above the base line is a measure of the relative amount of

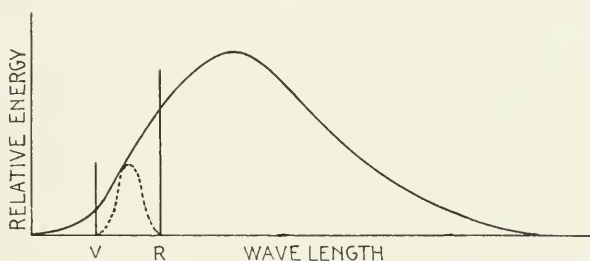


Fig. 2—Radiation curve of an incandescent solid. (Courtesy of M. Luckiesh.)

energy possessed. The amounts of energy for various wavelengths are by no means equal. The region to which the eye responds or is "tuned" lies between V (violet) and R (red). This region, following the diagram taken from Luckiesh (*Color and Its Applications*, page 8), is exaggerated in extent for the sake of clearness.

Figure 3, copied from the work of Langley, shows the relative distribution of energy in the spectra of the gas flame, the electric arc, the solar spectrum and the fire-fly.

As the temperature of an incandescent body is increased, the energy contained in the shorter wavelengths increases more rapidly than the energy in the longer wavelengths. In the visible spectrum the violet and the adjacent rays increase in intensity more rapidly with increase of temperature than does the red end. This causes the light emitted by an incandescent solid to become bluer in color (or less red, since the redness is the noticeable feature) as the temperature is increased. The effect of raising the temperature on the distribution of radiant

energy given out by an incandescient solid is shown in the curves given in Figure 4. The numbers on the curves indicate the absolute black-body temperatures (i. e. above -273°C , since $0^{\circ}\text{C}=273\text{ K.}$). The

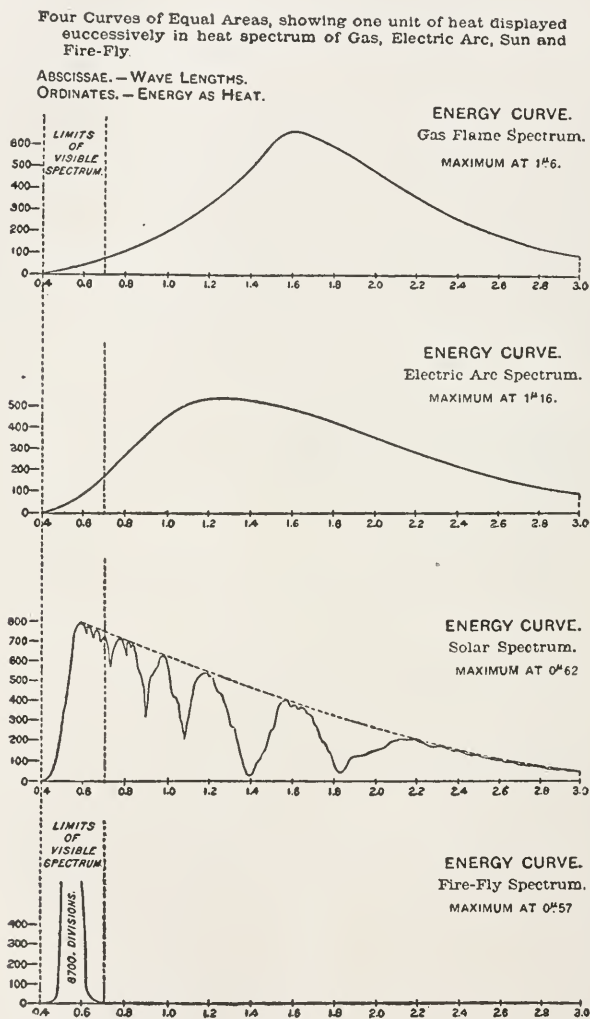


Fig. 3—Distribution of energy in spectra of gas flame, electric arc, sun and fire-fly.

wavelengths are in μ ; the rays to which the eyes are sensitive are enclosed between V and R. Thus, as the temperature is raised, the maximum of the radiation curve shifts toward the shorter wavelengths.

The energy distribution curve for sunlight (Figure 3) shows that the maximum lies in the visible region. This has brought forward the hypothesis that the eye, being as we know it to be the product of the processes of evolution, has become most sensitive to the rays of such wavelengths as are in maximum percentages in the radiation from the sun. As the maximum of the radiation curve shifts toward the shorter wavelengths, a greater proportion of the energy is found in the visible region and this accounts for the increased luminous efficiency. All tendencies in light production are to the end of the development of materials and methods which will enable the sources

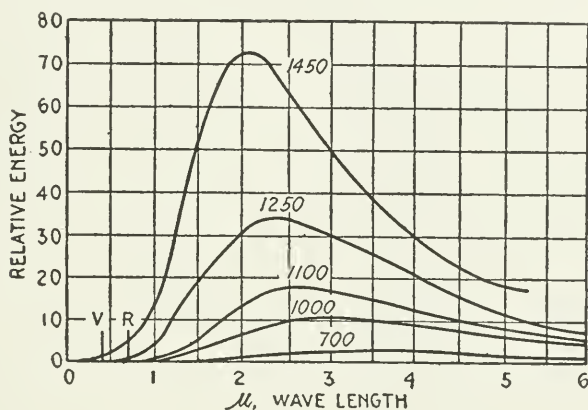


Fig. 4—Showing the effect of temperature on the radiation from an incandescent solid (black body). (Courtesy of M. Luckiesh.)

to be operated at higher temperatures. This is the advantage of the tungsten filament over the carbon filament lamp. The ideal source from the visual standpoint would be one which affords a continuous spectrum extending only from the blue to the orange roughly. The distribution of energy in the spectrum given out by the fire-fly approaches very closely this ideal. Langley and Coblentz have shown that ninety-five per cent. is available as luminous energy.

COMMON METHODS OF PRODUCING AND INVESTIGATING ULTRA-VIOLET, VISIBLE AND INFRA-RED RADIATIONS.

Spectrographs.

Spectrographs and spectrometers are the instruments commonly used in investigations upon those regions of the ultra-violet, visible and infra-red which are of interest to us either from the standpoint of

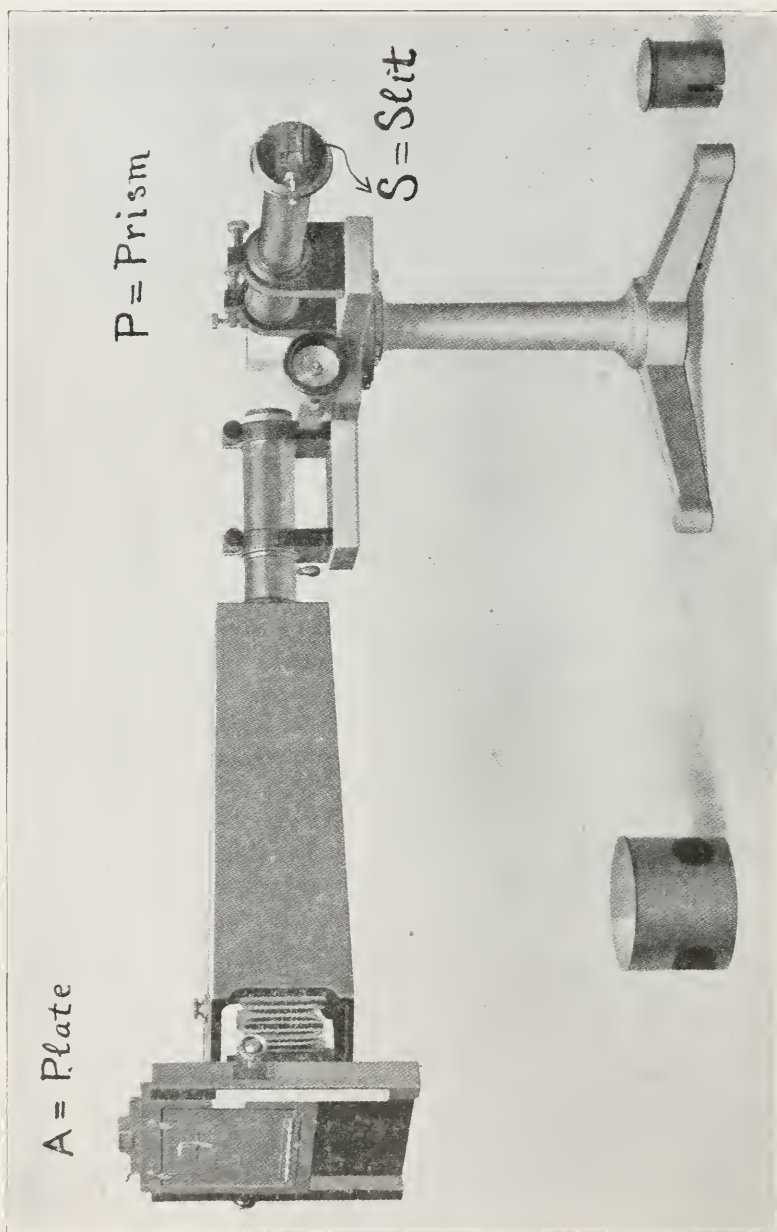


Fig. 5—A form of modern spectrometer.

the eye or of ophthalmic glass transmission. One of the modern forms of spectrograph is shown in Figure 5 and with the use of this diagram the essential features of this *prism* spectrograph will be pointed out. The three essential parts of such instruments are the collimator, the prism system and the photographic apparatus or telescope which may take its place in visual work. The source of light is placed before a narrow slit *S* in the collimator tube, or the light from the sun or an electric arc may be concentrated by means of a lens upon the slit. At the other end of this tube is placed an achromatic lens system and the slit and lens are so adjusted that parallel light will fall upon the prism *P*. In passing through the prism the light suffers dispersion and as a result there emerges a parallel beam of red light and a parallel beam of violet light with beams of the other wavelengths situated between them. The pencil of red light is brought to a focus upon the photographic plate *A* by means of an achromatic lens system in the telescopic tube: the violet rays as well as the remainder of the visible spectrum are likewise focused. Since the dispersion for these rays is different a spectrum, extending from red to violet, will be found upon the plate or visually obtained at the eye-piece of the telescope. In order that wavelengths may be determined the prism must be calibrated. One of the latest makes of spectrometers carries the constant deviation prism and is provided with a drum device, the barrel of which is calibrated in wavelengths. Such an instrument as this, or of a similar character, carrying a glass prism and glass lenses permits of the making of photographic or ocular observations of the visible spectrum. When, however, it is desired that investigations be carried on in the *ultra-violet*, all lenses and prisms must be of *quartz*, since this substance does not absorb the ultra-violet until the limit of about 1800 Angstroms is reached.

Other types of instruments employ the principle of auto-collimation. By this method the collimator and camera lenses are entirely suppressed, the only optical member being the prism itself. The employment of the principle of auto-collimation with a 30° prism simultaneously shortens the apparatus, simplifies the lens system and avoids trouble due to the rotatory properties of quartz, since the prism is traversed twice in opposite directions. The necessary condition for a pure spectrum is that all incident and refracted rays shall make the same angle with the refracting surface. This is accomplished by giving the front and back surfaces of the prism *P* (Figure 6) suitable spherical curvatures.

An excellent instrument to use for the photographic examination of the ultra-violet end of the spectrum is the Fery quartz spectro-

graph. This instrument is shown diagrammatically in Figure 6. The quartz prism *P* is silvered on the back and is ground in such a way that radiation received from a source in front of the slit at *A* is brought to a focus at *E* after reflection from the back of the prism. Since the prism in this instrument performs the functions of both the lenses and the prism in an ordinary spectrograph, there are no losses due to absorption other than those which occur in the prism.

The matter of a satisfactory source of illumination for work in the ultra-violet region is worthy of more than a passing remark. Iron arcs and similar devices are fairly rich in ultra-violet but are not continuous. The iron arc spectrum on direct current is redundant in lines; the same arc with condensers used across the arc affords a satisfactory source and a very uniformly and continuously burning

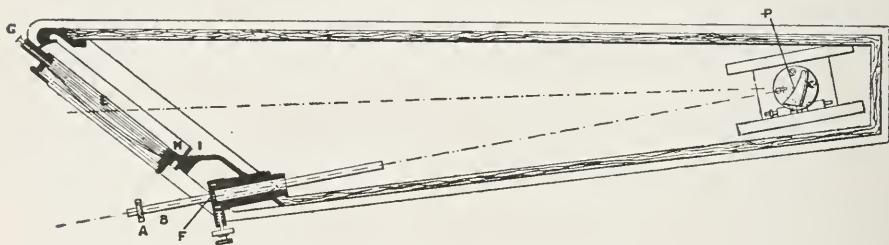


Fig. 6—The Fery quartz spectrometer.

one. A condensed spark discharge, using an induction coil, one electrode being made of iron and the other of an alloy of cadmium, aluminum, magnesium and zinc gives a most excellent spectrum for work in the ultra-violet; while it is fundamentally a line spectrum it has superposed upon it rather extensive portions of a continuous spectrum down to about 2300 t. m.

Another device used by some investigators upon the subject of glasses for protecting the eyes consists of reflecting the light from a mercury arc from the face of a magnesia block. The spectrum is, of course, discontinuous. In its use, however, a spectrum is formed by a small quartz spectrograph, the slit being wide enough to furnish bands from each ultra-violet line of sufficient width for photometerings. A series of exposures of equal length but with different known illuminations of the magnesia surface can be made and a comparison with the transmission through the media under examination carried out. The photographs as thus made can be measured for density on a polarization photometer or other device of a similar character and curves can be plotted showing the connection between the density and illumination for each line. It is thus possible to determine the

transmission of glass for each wavelength obtainable from the source of illumination.

Perhaps the best device for producing a continuous spectrum is that consisting of two electrodes—aluminum or brass, for example—under water and actuated by high frequency. A wireless oscillation transformer as a source of excitation has been found very satisfactory. There is less trouble with the question of purity of the water used but it does not afford quite as continuous a spectrum. The limit of continuity is, however, about 2100 t. m.; there is a gradual falling off in intensity of the rays in the extreme ultra-violet. Details in this matter are given by Howe in a paper on a Photometric Method of Measuring Ultra-violet Absorption (*Phys. Review*, Ser. II, Vol. 8, 1916).

Infra-red Spectrum.

Herschel in 1800 demonstrated the existence of a portion of the spectrum beyond the extreme visible red. He did this by means of a thermometer with a blackened bulb. A rise in temperature was indicated in the region just beyond the red. In the study of infra-red rays we need a prism made of a substance which does not absorb radiations of long wavelength and, in the second place, we need a device or receiving instrument which will indicate a very small rise of temperature due to the radiations absorbed. Prisms of rock-salt (or fluor spar: not now used much because of the scarcity) are employed. The instruments used for absorbing the radiations and indicating the consequent rise in temperature are the thermopile, the radio-micrometer and the bolometer.

Dr. Langley of the Smithsonian Institute carried on a very elaborate study of the infra-red solar spectrum making use of his bolometer. This instrument consists of blackened strips of platinum, about a tenth millimeter in breadth and a hundredth millimeter in thickness, arranged to form two arms of a Wheatstone bridge. When the usual galvanometer and battery connections are made, the resistances in the remaining arms are adjusted so that the galvanometer shows no deflection. When radiation falls upon one arm of the bridge, however, the balance of the bridge is destroyed and a deflection of the galvanometer follows. This galvanometer deflection affords a means of relative measurement of the absorption of energy. The sensitiveness of the instrument is such that a rise of temperature amounting to not more than one hundred-millionth of a degree Centigrade can produce a measurable deflection. "What would be a dark

band in the spectrum, could our eyes be affected by the long infra-red waves, will fail to heat the platinum strip and the galvanometer deflection will be diminished or reduced to zero'' (*Edser. Light*, page 345). By means of this bolometric device Langley investigated the infra-red through a region extending from $0.76\ \mu$ (7600 t. m.) to $5.3\ \mu$ (53,000 t. m.).

In 1880 Sir William Abney obtained through the use of specially prepared plates a photographic record out to $1.1\ \mu$. The special character of plates and the difficulty of handling photographic work in regions sensitive to the red, together with the low limit of the radiations recorded, make this method practically useless for experimental work.

Following Langley, a series of most valuable investigations has been carried out by Rubens, Nichols, Aschkinass, Wood, von Baeyer and others working in this region. By means of the radiometer, the method of "reststrahlen" and focal isolation the investigations in the infra-red have been gradually extended to about $343\ \mu$ or roughly one-third of a millimeter.

Experimental Apparatus for Infra-red Transmission of Glass.

The refinements and the extended ranges of wavelength obtainable by several of the methods just mentioned are not necessary in investigating the absorption and transmission of the ocular media and of glass in the infra-red region. Tests by a considerable number of investigators show that the transmission of the eye media becomes very small after the region $3.5\ \mu$ is passed, while the transmission of ordinary glass drops, in general, to the order of 10 to 15 per cent. at $4.5\ \mu$.

A quite satisfactory form of instrument for the examination of the transmission of glasses and similar media in the infra-red region is the Hilger infra-red spectrometer. The essentials of this instrument are shown diagrammatically in Figure 7. In Figure 8 is given a photographic reproduction of this instrument.

Radiation from a suitable source is allowed to pass through a narrow slit *S* of the order of magnitude of one-hundredth of an inch in width. The radiation from *S* is received by a concave mirror *K* by which it is collimated. It then falls on the rock-salt prism *P*, by which it is dispersed and received on the plane mirror *M* and reflected to the concave mirror *R*. This concave mirror *R* then focusses the radiation on the slit *T*, behind which is mounted a Hilger bismuth-silver thermopile which acts as the receiving instrument. The mirrors

are made of nickeled steel. The slit at T is of the order of one one-hundredth inch in width. The prism P and the mirror M are mounted on a table which can be rotated around a vertical axis by means of a fine screw which is attached to a calibrated drumhead. From this drumhead the wavelength used for experimental purposes can be read directly. By this rotation of the prism P any desired part of

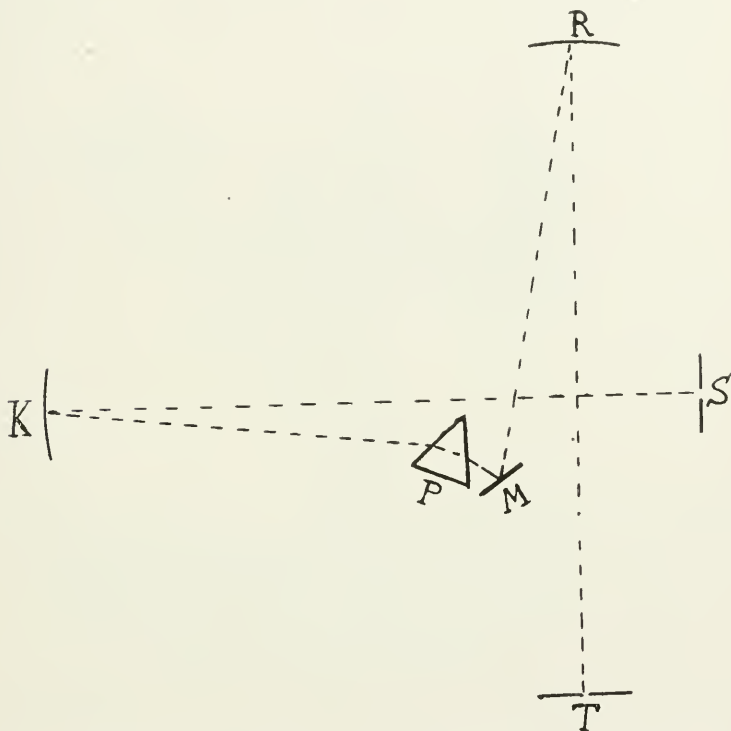


Fig. 7—Essentials of construction of the Hilger infra-red spectrometer.

the spectrum can be made to fall upon the slit T . The thermopile and the whole instrument must be carefully protected from external radiation.

The thermopile serves as the receiving instrument in this type of instrument. Nobili devised what he called a "pile" or a form of thermoelectric battery in which there are a large number of elements in a very small space. For this purpose he joined the couples of bismuth and antimony in such a manner that, after having formed a series of five couples as shown in Figure 9 (B) the bismuth from b was soldered to the antimony of the second series similarly arranged; the last bis-

ment of this to the antimony of the third and so on. The whole pile thus consisted of a number of bismuth-antimony couples. The couples can be insulated from each other by means of small paper bands covered with varnish and are then enclosed in a suitable frame *P* (Figure 9A) so that the only solderings appear at the two ends of the pile. Two small binding posts, *m* and *n*, insulated in an ivory ring, communicate in the interior, one with the antimony, representing the positive pole, and the other with the last bismuth, representing the

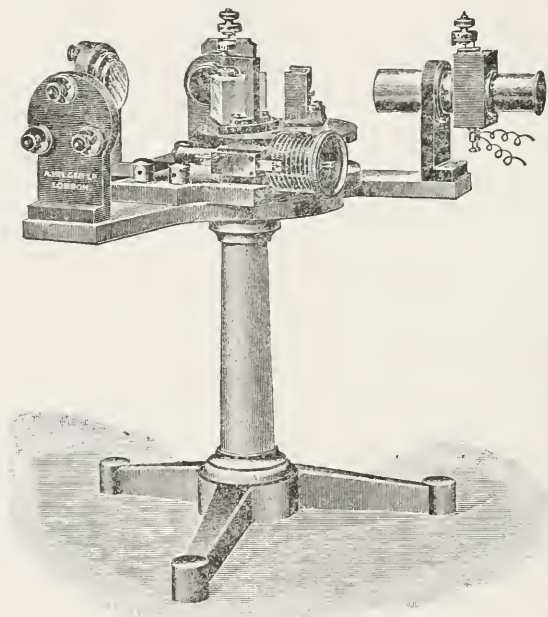


Fig. 8—The Hilger infra-red spectrometer.

negative pole. These terminal points then connect with a galvanometer: this instrument detects the thermo-electric current. The action of the thermopile depends upon the principle that if one set of junctions is at a higher temperature than the second set an electric current is produced. If these thermo-couples are made of the proper elements and are connected in the circuit of a sensitive galvanometer, extremely small fractions of a degree rise in temperature can be detected. The electric current arises in every case, however, because of the difference in temperature of the two faces of the thermo-junctions.

A sufficiently sensitive galvanometer is used as the instrument for the detection of the current. The strength of the current is propor-

tional to the mirror deflection. This deflection can be measured by means of a lamp and scale.

For investigations in the infra-red transmission of glass it is found that the Nernst glower is a very satisfactory source. The distribution of energy in wavelengths of the emission of a Nernst glower varies considerably with the temperature. The radiation from such a glower is characterized by two maxima at about $2.5\ \mu$ and 5.5 to $6\ \mu$. At low temperatures (2 watts to 7 watts) the latter maximum ($5.5\ \mu$) is the more prominent. As the temperature is raised (11 or more watts) the maximum of the energy distribution appears in the region of about $2\ \mu$ (See paper by Coblenz, *Bulletin of the Bureau of Standards*, Vol. 4, 1907.). This region from $0.7\ \mu$ to $3\ \mu$ is that which is of interest from the standpoint of transmission and absorption in the eye

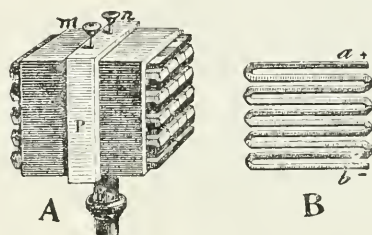


Fig. 9—The thermopile.

media and in various kinds of glass. The Nernst glower is, therefore, used in such experimental work with the maximum energy in the region of 1.5 to $2\ \mu$.

Spectra of Illuminants.

The spectral distribution of energy in the radiation from different illuminants is of great importance in the consideration of color. This variation in the spectral character of illuminants is due to the temperature and composition of the radiating body and also to the state in which it exists when giving out luminous energy. A gaseous body gives out only certain definite rays and the spectrum is said to be a *line* spectrum. Quite often these spectral lines are crowded together in such a manner as to give to the spectrum a fluted or banded appearance. This is known as a *band* spectrum. Also, the constancy of the spectrum lines given by any substance (element) in gaseous form is a striking feature. For example, the visible spectrum of sodium consists of a double line ($5890\ \text{\AA}$ and $5896\ \text{\AA}$) and whenever this double line is found in a spectrum it is certain that sodium is

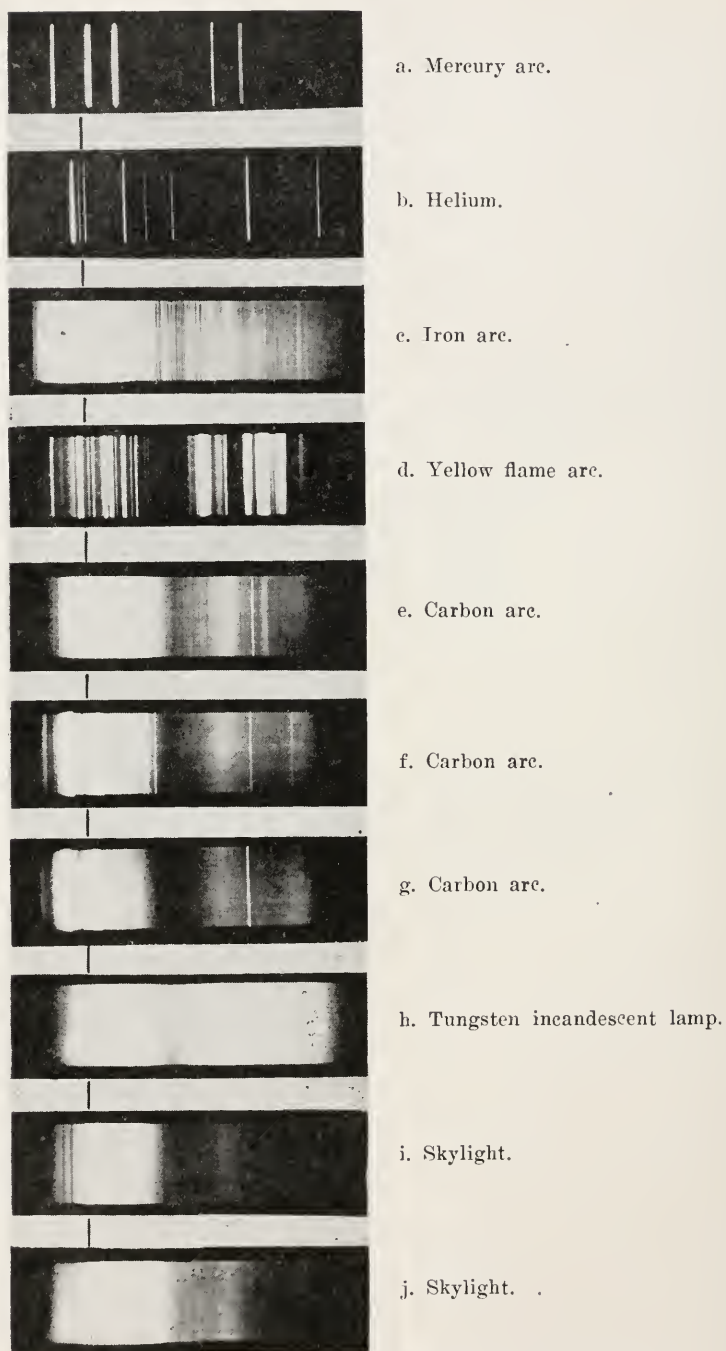


Fig. 10—Representative spectra. (Courtesy of M. Luckiesh.)

present in the radiating substances. This constancy of spectra forms a basis of analysis more sensitive than the most accurate chemical tests. The element helium was discovered by means of spectroscopy some-

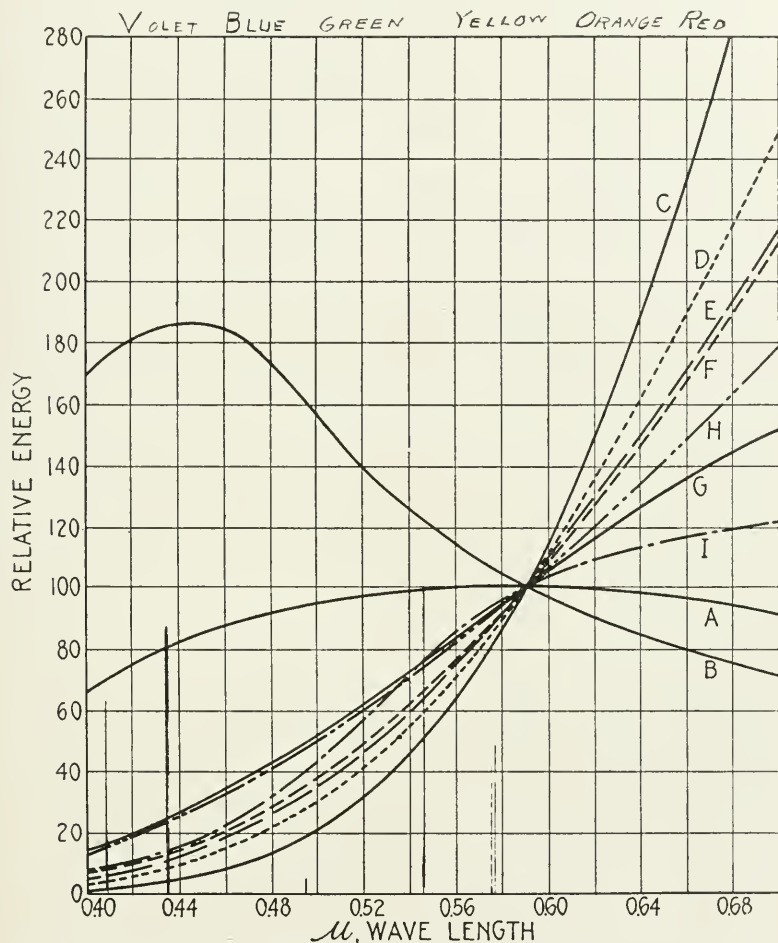


Fig. 11—Distribution of energy in the visible spectrum of various illuminants. Significance of letters on curves given in Table II. (Courtesy of M. Luckiesh.)

time before it was terrestrially found. The vacuum tube, the electric spark, the arc and the flame are of use in studying the spectra of elements and their compounds.

A continuous spectrum is emitted by an incandescent solid. The spectrum of an incandescent electric lamp, for example, is continuous.

The energy of the electric current running through such a filament is converted into radiant energy. The continuous spectrum is, as its name signifies, the antithesis of the line spectrum: or it may be considered as an infinitely numbered line spectrum. There are no breaks or apertures in the emission. Sometimes both a line and a continuous spectrum are emitted by an illuminant. Such a condition exists in the ordinary electric carbon arc. The center of the arc is an incandescent solid and therefore emits visible rays of all wavelengths; the incandescent gas of the arc between the electrodes emits a line spectrum which depends as to its appearance upon the surrounding medium and the character of the carbon electrodes. In Figure 10 are shown several representative spectra photographed by means of a sensitive spectrograph using Cramer spectrum plates which were made specially sensitive to the visible rays (Luckiesh: *Color and Its Applications*, page 17). The reproduced spectrograms contain line spectra, banded spectra and continuous spectra. It will be seen that the two gases, mercury and helium, emit line spectra. The arcs emit both continuous and line spectra. The relative prominence of the line spectra depends upon the relative intensities of the radiation from the arc as compared with that from the solid electrodes. For instance, the line spectrum is much more prominent in the yellow flame arc than in the ordinary carbon arc. As is well known, the arc vapor contributes a much greater proportion of the light in the former than in the latter illuminating source. The line spectrum of carbon is subject to changes because of the character and amounts of impurities which may be present in the carbons. The three spectra of the carbon are given in Fig. 10 were taken within a few minutes' time and show these variations. (The apparent absorption in the green region in all these photographs is due to lack of sensitiveness of the plates used in the green-blue region). The tungsten filament, *h*, is seen to emit a continuous spectrum. Two spectrograms of light from the sky are shown in *i* and *j* and bring out (perhaps rather poorly) the presence of narrow black absorption lines. The solar spectrum is of interest particularly because of the fact that it is a continuous band crossed by many fine dark lines. These lines were discovered in all probability by Wollaston in 1802 but were studied with better instruments by Fraunhofer in 1814 and are consequently known as Fraunhofer lines. These absorption lines are due to the removal of the corresponding radiations by the vapors in the solar atmosphere. The chief Fraunhofer lines with their wavelengths, colors and sources are given in Table I.

TABLE I.
Principal Fraunhofer Lines.

Line.	Wave-length.	Color.	Source.
A	0.7594 μ	Red	Oxygen in atmosphere
a	0.7185	Red	Water vapor
B	0.6876	Red	Oxygen in atmosphere
C	0.6563	Red	Hydrogen in sun
D ₁	0.5896	Yellow	Sodium in sun
D ₂	0.5890	Yellow	Sodium in sun
E	0.5270	Green	Calcium in sun
b ₁	0.5184	Green	Magnesium in sun
b ₂	0.5173	Green	Magnesium in sun
b ₄	0.5168	Green	Magnesium in sun
F	0.4861	Blue	Hydrogen in sun
G	0.4308	Violet	Calcium in sun
H	0.3969	Violet	Calcium in sun
K	0.3934	Violet	Calcium in sun

Figure 11 gives curves showing the spectral distribution of energy in the visible region for various illuminants. These data were obtained chiefly by Hyde, Ives, Cady and Luckiesh working in the Nela Research Laboratory. Table II gives the numerical data as well as the significance of the letters attached to the different curves (Luckiesh,

TABLE II.

	A	B	C	D	E	F	G	H	I
Wave length	Black Body at 5000° Absolute (Noon Sunlight)	Blue Sky	Hofner lamp	Carbon incandescent lamp 3.1 w. p. m. h. c.	Acetylene	Tungsten incandescent lamp 1.25 w. p. m. h. c.	Tungsten incandescent lamp 0.5 w. p. m. h. c.	D. C. arc	Welsbach gas mantle
0.41 μ	72.0	177	1.9	4	5.5	.....	16.5	.....	.....
.43	79.0	185	3.5	7	9.6	.....	22.5	21.8	.....
.45	84.3	187	6	12	15	16.7	30	29	17.5
.47	91.0	180	10.5	18	21.9	23.5	38	37	26.4
.49	92.5	162	16.3	25.5	30.3	32.7	47	45.5	38.3
.51	96.0	146	25.5	34.5	40	42.6	56.5	55	51
.53	98.0	132	37.5	47	52	54.9	67	65.5	64
.55	99.0	120	53.2	62	66.5	68.6	78	76	78
.57	100.0	108	74.5	79	82	83.4	88	88	90
.59	100.0	100	100	100	100	100	100	100	100
.61	100.0	93	130	123	118	117	111	113.5	107
.63	98.5	87	168	148	139	136	121	127	111
.65	97.1	82	210	176	160	157	131	142	114
.67	95.5	77	260	204	182	179	140	156	119
.69	93.5	72.5	320	204	205	202	148	170	120

Color and Its Applications, page 21). It will be noted that all curves are plotted in such a manner that the relative energy of wave-length 0.59μ (approximately sodium D) equals one hundred. This method of plotting gives the relative distribution of energy for approximately the same amounts of total light sensation. All of these curves show

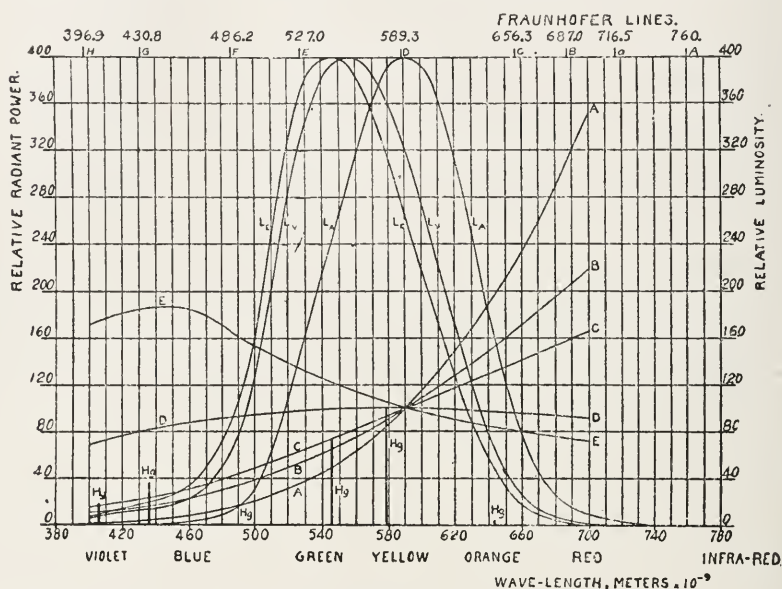


Fig. 12—Relative spectral distribution of radiant power in various sources: *A*=Hefner lamp, H. E. Ives, Trans. I. E. S., 5, p. 208, 1910; *B*=acetylene flame, Coblenz and Emerson, B. S., 13, p. 363, 1916; *C*=tungsten (gas) incandescent lamp (No. 1717) at 15.6 lumens per watt, data by Coblenz; *D*=black body at $5,000^{\circ}$ absolute—approximately sunlight, computed from Planck equation; *E*=blue sky, H. E. Ives, Trans. I. E. S., 5, p. 208, 1910; *Hg*=Heraeus quartz-mercury lamp, 81 watts, W. W. Coblenz, B. S., 9, p. 97, 1913.

Relative visibility: L_v =Relative visibility curve for the average human eye (or luminosity of a source having constant radiant power throughout the visible spectrum), Coblenz and Emerson, B. S., 14, p. 192, 1917.

Relative luminosity=relative radiant power times relative visibility: L_A =luminosity of Hefner lamp; L_E =luminosity of blue sky.

(From Technologie Paper No. 119, 1919. Permission of The Bureau of Standards.)

that all artificial light sources, such as the Welsbach, acetylene and tungsten incandescent lamps are relatively rich in longer visible wave-lengths and decidedly deficient in terms of percentages in the extreme blue and violet.

Figure 12 is taken from a recent paper by Gibson and McNicholas (*The Ultra-violet and Visible Transmission of Eye-Protective Glasses*, *Bulletin of Bureau of Standards*, June, 1919) and gives data by Ives

and by Coblenz. The descriptive matter accompanying the diagram makes clear the significance of the curves.

TRANSMISSION AND ABSORPTION OF GLASS FOR ULTRA-VIOLET, VISIBLE AND
INFRA-RED RADIATION.

The Ultra-violet and the Visible.

It is a well known fact that ultra-violet light (light of wave-length less than 3900 t. m. roughly) may exert harmful physiological effects on the eye and skin, but just how much of this deleterious action is to be ascribed to general energy radiation and how much to specific radiation is a matter that has by no means been settled. It is quite generally agreed that the extreme ultra-violet rays, i. e., those of wave-length 3000 t. m. or less, cause injury when in sufficient quantity or intensity. There are those who claim, and with considerable evidence in support thereof, that the rays between 3000 and 3600 t. m. also cause injury. Nutting (*Bureau of Standards*, Circular No. 28) believes that the 3650 t. m. of the mercury arc contributes about 80 per cent. of the "fatigue effect" when this arc is used as a source of light. Whatever may be the extent of the extremely harmful regions and whatever opinions may be held as to what radiations are or are not harmful, there are still many industrial processes requiring special protection of the eyes, and the excessive amount of ultra-violet or of infra-red radiation may be and generally is one of the very important factors. It is therefore a matter of importance to know much of the physiological and pathological effects of radiation: these we shall consider in another part. It is likewise of great importance that we should know how much of a specified radiation gets through a given sample of glass or other absorbing medium.

In 1889 Widmark (*Skand. Arch.* I, 264) made experiments on the subject of the effects of ultra-violet light on the eyes of laboratory animals and reproduced the stages of electric ophthalmia in rabbits' eyes. Perhaps stimulated by the possibilities of the protection of the eyes suggested by Widmark's experiments, Schulek (*Ungar. Beitr. z. Augenheilk.* I, 101, 1895 and 2, 1899) first studied the means of protecting the eyes against ultra-violet rays and found that certain liquids had the highest absorptive powers of the transparent media investigated. These liquids absorbed all rays below 3960 t. m. He suggested that these solutions should be enclosed in flat, oval-shaped glass chambers made to fit the eyes and to protect them from injuries due to the ultra-violet radiations.

Stearke (*Arch. f. Augenheilk.* 50, 1904), Vogt (*Arch. f. Augen-*

heilk. 59, 1907) and Hallauer, (*Vers. d. Ophth. Ges. Heidelberg*, 1907) studied the absorptive properties of blue uviol, yellowish and smoky-gray glasses. The last named worker produced by a secret process the so called Hallauerglas. Following a like study Fieuzal (*Bull. de la clin. nat. oph.* No. 3, 1885) produced a glass known as Fieuzalglass. Also a yellow-green glass patented under the name of Enixanthosglas was offered, as well as a variety of modifications.

In 1907 Schanz and Stockhausen (*Klin. Monatsbl. f. Augenheilk.* 1907) after finding that electric ophthalmia could be produced through 18 mm. of common glass, began to study the problem of manufacturing a colorless glass of high ultra-violet absorptive power. In 1909 they produced and patented a glass of higher absorptive power than hard flint and named it Euphosglas. This glass has a light, yellowish-green tinge and fluoresces in ultra-violet light.

In 1909 Bireh-Hirschfeld (*Zeitschr. f. Augenheilk.* 21, 1909) studied photometrically the absorptive power of various glasses with considerable accuracy. At about the same time Vogt (*Arch. f. Augenheilk.* 59, 1907) compared a new and very hard flint glass produced by Schott with his absorptive solutions and found that it had about the same absorptive efficiency, beginning at 4050 t. m. and giving practically complete absorption below 3960 t. m. Hallauer (*Arch. f. Augenheilk.* 54, 1909) measured photometrically the absorption powers of the various protective glasses then available.

As the number of kinds of glass for cutting out various wavelengths became greater and more available, the question arose as to what spectral range constituted the best illumination. Voege (*Electro. Zeits.* No. 33, 1908) maintained that the light from the clouds or clear sky had been for ages a normal illumination for the eyes and that it contained a considerable amount of ultra-violet light as low as 3000 t. m. Hertel and Henker (*Arch. f. Ophthal.* 73, 1910) carried out a very elaborate set of experiments in the Zeiss Laboratory, Jena, and came out in support of Voege. These experimenters believed that the best glass is one that will reduce the spectrum of the particular light to which the eyes are exposed to the closest possible approximation to the spectrum of cloud and sky lights. For observation of the strongest arc lights at close range they considered the neutralglas F 3815 of Schott to be best, claiming that this glass, in layers thinner than any other glass, may be used to observe directly a bare 20 amperes arc light at a foot and a half without injury, since the spectrum is about the same as that of cloud light minus the ultra-violet portion. Schanz and Stockhausen (*Arch. f. Ophth.* 75, 1919) criticized this work, particularly on the basis that skylight or cloud light cannot be taken as

the ideal light. They furthermore cite the work of Handmann (*Monatsbl. f. Augenh.* 47, 1909) showing that a very large group of cataracts began in the quadrant of the lens most exposed during life to the light of the sky. It may be stated, in brief, that during the past ten years these various discussions and opinions have caused the number of protective eye glasses for general wear or specific purposes to be multiplied and attention to be paid to glasses affecting the ultra-violet, the visible and the infra-red.

No survey of the development of protection glasses would be complete without mention of the paper on The Preparation of Eye-Preserving Glass for Spectacles (*Trans. of Roy. Soc.*, 1913) delivered by Sir William Crookes before the Royal Society on November 13th, 1913. Crookes was engaged from 1909 to 1913 in connection with the Glass Workers Cataract Committee of the Royal Society and experimented on the effect of adding various metallic oxides to the constituents of glass in order to cut off the ultra-violet and the infra-red rays. The main object of the researches was to prepare a glass which would cut off the rays from highly heated molten glass which apparently damaged the eyes of workmen. Photo-spectrographic and other examinations were made of the radiation emitted from the molten glass under working conditions. Sir Wm. Crookes, in the paper referred to, writes: "Taking the ordinary limit of visibility to lie between 3900 t. m. and 7600 t. m. it is seen that with an exposure of three hours to the highest heats the strength of impression does not extend much into the ultra-violet. The heat rays are very strong and if injury to the eye is caused by exposure to radiation from the molten glass, a protective glass should be opaque to infra-red rays. These being present in the radiation from molten glass in far greater abundance than the ultra-violet rays, the inference is that it is to the heat rays rather than to the ultra-violet rays that glass workers' cataract is to be ascribed. It is, however, certain that exposure to excess of ultra-violet light also injuriously affects the eye. That the ultra-violet rays act on the deeper-seated portions of the eye is shown by the intense fluorescence of the crystalline lens induced by these rays. Besides the invisible rays at each end of the spectrum, the purely luminous rays, if present in abnormal intensity, are found to damage the eye. It, therefore, would be an advantage if in addition the obscuring glass for the spectacles were to be of a neutral or gray tint."

In discussing the results of his experimental work Crookes says that the first necessity is to find a glass which will cut off as much as possible of the heat radiation. "For ordinary use," he writes, "when no special protection against heat radiation is needed, the choice will

rest on whether the ultra-violet or the luminous are most to be guarded against; or whether the two together are to be toned down." His experimental work gave glasses which were very effective in cutting out wavelengths shorter than 3700 t. m. The colors of these glasses were pale-green, yellow and neutral. Likewise glasses of much transparency were produced which transmitted from 99.5 to 70 per cent. of the incident light. The choice between this range of glasses would depend on the conditions required. Special glasses were devised which are "restful to the eyes in the glare of the sun on chalk cliffs, expanses of snow, or reflected from the sea. * * * Moreover, they have the advantage of cutting off practically all of the ultra-violet rays and also a considerable amount of the heat radiation."

While a great deal of work has been done on ultra-violet light, both in Europe and in America, very few *quantitative* investigations have been made. Bell and Luckiesh were two of the first experimenters to make quantitative investigations along these lines. Bell (*Electrical World*, April, 1912 and *Amer. Acad. Proc.* 46, April, 1911, etc.), by means of a thermopile and sensitive galvanometer, has obtained valuable data on the ultra-violet component of artificial light sources. Luckiesh (*Electrical World*, June, 1912, *Illuminating Eng. Soc.*, April, 1914, *Elect. World*, May 24, 1913, etc.) used a photographic method to obtain transmission curves of various kinds of glass.

Ham, Fehr and Bitner, using a photographic null method for measuring absorption in the ultra-violet, published their results (*Journal of the Franklin Institute*, Sept., 1914) upon the transmission and minimum lines of various kinds of glass.

In 1918 Coblentz and Emerson (*Technologic Papers of the Bureau of Standards*, No. 93, 1918) issued a paper on the subject of Glasses for Protecting the Eyes from Injurious Radiations. This paper deals quite largely with the visible region beyond 0.5μ and with the absorption of glasses in the red and infra-red regions. Coblentz and Emerson conclude: "For protecting the eye from ultra-violet light, black, amber, green, greenish-yellow, and red glasses are efficient. Spectacles made of white crown glass afford some protection from the extreme ultra-violet rays which come from mercury-in-quartz lamps and from electric arcs between iron, copper or carbon. The vapors from these arcs emit but little infra-red radiation in comparison with the amount emitted in the visible and in the ultra-violet."

In June 1919 Gibson and McNicholas issued a paper (*Technologic Papers of the Bureau of Standards*, No. 119, 1919) on the Ultra-violet and Visible Transmission of Eye-Protective Glasses, in which they report the results of a long series of careful spectrophotometric obser-

vations for different wavelengths upon various eye-protective media. A logarithmic relation connects the transmittance and the thickness of glass, thereby enabling a direct comparison of the transmissions and absorptions of various kinds of glass of different thicknesses. A considerable number of their results in the form of curves appear in other portions of this essay.

Let us consider some of these experimental methods and the results of various investigators somewhat in detail. There are various means and methods of studying the transparency of media for the ultra-violet. Photography is, without doubt, the most readily applicable. The radiometer, thermopile and bolometer could be used, but temperature changes, air currents, magnetic disturbances and general inconveniences of such methods bar them out as useful in such investigations as are now being discussed. Photography offers several distinct advantages: among these may be mentioned: (1) Less adjustment than is required in any other method, (2) extremely faint lines can be detected and measured and (3) the photographic plate gives a permanent record of the test. However, be it said that when the transmission is to be accurately determined the photographic method is a very tedious procedure. The photographic action is determined by the density of the plate. In plotting the density of the plate against the logarithm of the illumination a straight line relation is found over a certain range of illumination. By no means, however, is the density of the silver deposit proportional to the logarithm of the intensity of radiation throughout any extremely wide range of illumination. Furthermore, rays of various wavelengths show different relations between density of the silver deposit and the illumination.

Ham, Fehr and Bitner (*Journal of the Franklin Inst.*, page 299, 1914) used the null photographic method of determining transmissions. By making several exposures on the same plates, various sources of error such as changes in temperature, character of plate, and so forth, could be eliminated and there would be practically no errors introduced due to the emulsion and the development. By making several exposures with various reduced intensities of the incident beam a very close match could be obtained between two adjacent images of the same spectral line and a fairly close estimate of the absorption obtained for that particular wavelength. For example, if the effect produced by the original beam of light after passing through the medium were the same as the effect produced by the beam when striking the plate after a reduction of 25 per cent. in intensity, the absorption of the medium would be 25 per cent. of that particular wavelength. The experimental problem, therefore, consisted of two parts: (1) the

determination of the equality of the densities of the two adjacent images on the photographic plate and (2) the reduction of the incident beam of light by a known amount.

Figure 13 (Ham, Fehr and Bitner, *Journal of the Franklin Institute*, Sept., 1914) shows how important it is in such work to increase this time of exposure until no more lines appear on the spectrogram. With the apparatus used it was found that an exposure of 120 seconds was sufficiently long to bring out the line of minimum wave-

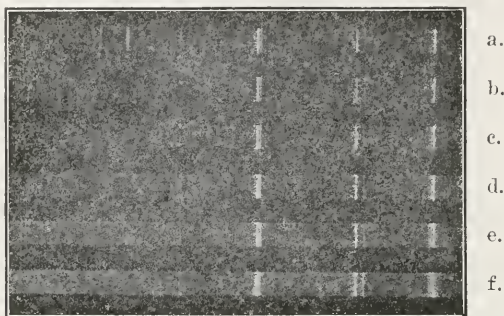


Fig. 13—Transmission of clear glass. (After Ham, Fehr and Bitner, *Jour. of Franklin Inst.*, 1914.)

- a. Quartz, 10 seconds.
- b. "American" clear glass, 10 seconds.
- c. "American" clear glass, 20 seconds.
- d. "American" clear glass, 30 seconds.
- e. "American" clear glass, 60 seconds.
- f. "American" clear glass, 120 seconds.

length in all the glasses tested, whether high or low in the transmission of visible light.

Figures 14, 15, 16 and 17, taken from the same paper, were made with exposures of 120 seconds each. The percentage transmission was obtained by the use of a 1.25 watt per candle tungsten lamp and a flicker photometer. The authors say: "In looking over the data obtained in regard to the minimum wavelength transmitted, some very interesting results may be noted. For example, the faint pink of No. 4 transmits as much ultra-violet as the light blue of No. 20. Since both glasses have about equal transmissions for visible light, it was to be expected that the one nearer the red end of the spectrum would cut off more ultra-violet, but this case clearly shows that no dependence may be placed on the color of the glass. Again, Nos. 7 and 8, of very nearly the same shade of yellow, show widely different degrees of transmission of ultra-violet, the 'Noviol' not transmitting even all of

the visible wavelengths while the other yellow glass transmits as far down as the 3150 t. m. line. Euphos glass No. 11 cuts off the ultra-violet very sharply at 4050 t. m. but Nultra glass appears to be somewhat better from a practical standpoint for it barely transmits the 3650 line (less than 1 per cent. by actual test) and absorbs only 15 per cent. of the visible light. The most remarkable glass of all is the orange-yellow of No. 5 (figure 18) which appears to transmit selectively be-

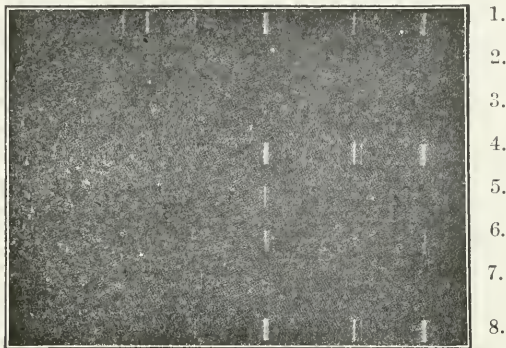


Fig. 14—Minimum lines transmitted by various glasses. (After Ham, Fehr and Bitner, *Jour. Franklin Inst.*, 1914.)

No.	Absorbing Medium	Per Cent.	Minimum Line $\mu\mu$
		Transmission for Tungsten Light at 1.25 w.p.e.	
1.	Quartz .....	...	...
2.	Very deep red glass.....	4.1	...
3.	Red glass	17.8	...
4.	Faint pink	50.1	313
5.	Orange yellow	38.3	334
6.	Yellow	54.3	334
7.	Yellow ("Noviol")	78.0	546
8.	Very light yellow.....	78.8	313

tween 3340 and 4050 t. m., although its greatest transmission is at the other end of the spectrum."

One criticism of this work of Ham and his colleagues is that the mercury arc spectrum, with its comparatively few lines, was used as a light source. Hence the minimum transmission may not be the minimum line recorded. The remedy lies in the use of a continuous spectrum, or as nearly continuous as is obtainable. A method of under-water spark has been already referred to as being of great use in such work.

Smith and Sheard (*Journal of the Optical Society of America*,

page 26, 1919) made use of a condensed spark across two electrodes, one made of iron, the other of an alloy, of cadmium, aluminium, magnesium and zinc. Figure 18 gives the photographic results of the minimum transmissions of the various samples of glass specified at the side. A Fery quartz spectrograph was used. "The times of exposure were made nearly the same throughout the experiment. The intensity of spark, however, fluctuated so much that it is not possible to make comparisons concerning the amount absorbed by the different thicknesses.

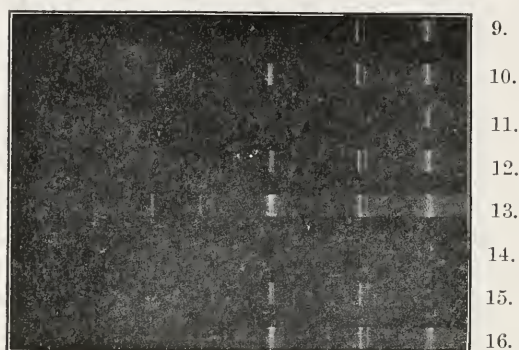


Fig. 15.—Minimum lines transmitted by various glasses. (After Ham, Fehr and Bitner, *Jour. Franklin Inst.*, 1914.)

No.	Absorbing Medium	Per Cent. Transmission for Tungsten	Minimum Line
		Light at 1.25 w.p.e.	$\mu\mu$
9.	Faint yellow ("Nultra")	85.0	365
10.	Faint yellow	84.3	313
11.	Yellow green ("Euphos")	72.0	405
12.	Yellow green	71.6	365
13.	Faint yellow green	82.5	302
14.	Very deep green	2.6	405
15.	Dark green	5.0	365
16.	Green	52.0	324

* * * It was the purpose of this part of the experiment to show only limits to which these glasses transmit radiations in the ultra-violet end of the spectrum for fairly long exposures. From the results obtained it is seen that the amethyst and the blue glasses transmit farthest into the ultra-violet. They seem to absorb all wavelengths beyond 3091 t. m. On the other hand the deeper-colored Noviol transmits least far into the ultra-violet. It apparently absorbs everything beyond about 5000 t. m." No quantitative measurements are attached to these spectrograms but they do point out the fact that ambers of various kinds (called by such names as oliveye, luxfel,

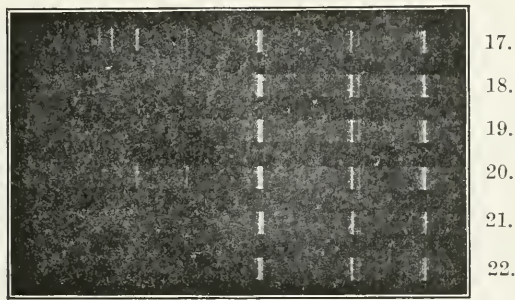


Fig. 16.—Minimum lines transmitted by various glasses. (After Ham, Fehr and Bitner, *Jour. Franklin Inst.*, 1914.)

No.	Absorbing Medium	Per Cent.	Minimum Line $\mu\mu$
		Transmission for Tungsten Light at 1.25 w.p.e.	
17.	Quartz .....	...	...
18.	Dark blue violet glass.....	2.5	334
19.	Blue	8.3	334
20.	Light blue ("Tungsten")	46.1	302
21.	Reddish purple	23.2	334
22.	Dark flesh color.....	44.3	334

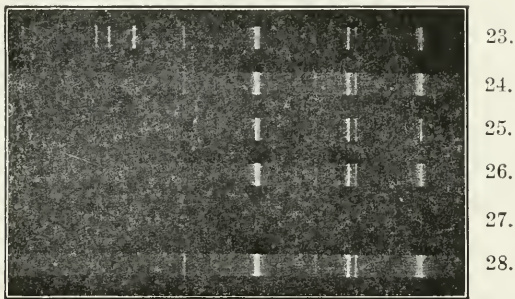


Fig. 17.—Minimum transmission of various glasses. (After Ham, Fehr and Bitner, *Jour. Franklin Inst.*, 1914.)

No.	Absorbing Medium	Per Cent.	Minimum Line $\mu\mu$
		Transmission for Tungsten Light at 1.25 w.p.e.	
23.	Quartz .....	...	...
24.	Light flesh color	73.8	334
25.	Dark gray	15.3	334
26.	Medium gray	36.8	334
27.	Ground glass	50.5	365
28.	Clear glass ("American")	90.2	313

	Thickness of Glass
Condensed Spark .....	.....
Euphos	5.0 mm
Pfund	2.6 mm
Crookes A	3.2 mm
Crookes B	2.8 mm
Noviol b.	4.9 mm
Noviol a.	4.0 mm
Smoke No. 0.....	2.3 mm
Smoke No. 1.....	2.3 mm
Smoke No. 2.....	2.3 mm
Luxfel	2.4 mm
Oliveye	2.5 mm
Amethyst No. 1.....	2.6 mm
Amethyst No. 2.....	4.8 mm
Amethyst No. 3.....	3.3 mm
Resistal	3.4 mm
Blue No. 0.....	2.5 mm
Blue No. 1.....	2.5 mm
Blue No. 2.....	2.5 mm
First Amber	4.1 mm
Light Amber	2.5 mm
Medium Amber	4.0 mm
Dark Amber	4.3 mm
Dark Amber No. 2...	2.3 mm
Light Amber No. 2...	2.4 mm
Nactic a.	3.4 mm
Nactic 21	3.3 mm
Nactic 22	3.0 mm
Nactic 23	3.2 mm
Nactic 24	3.5 mm

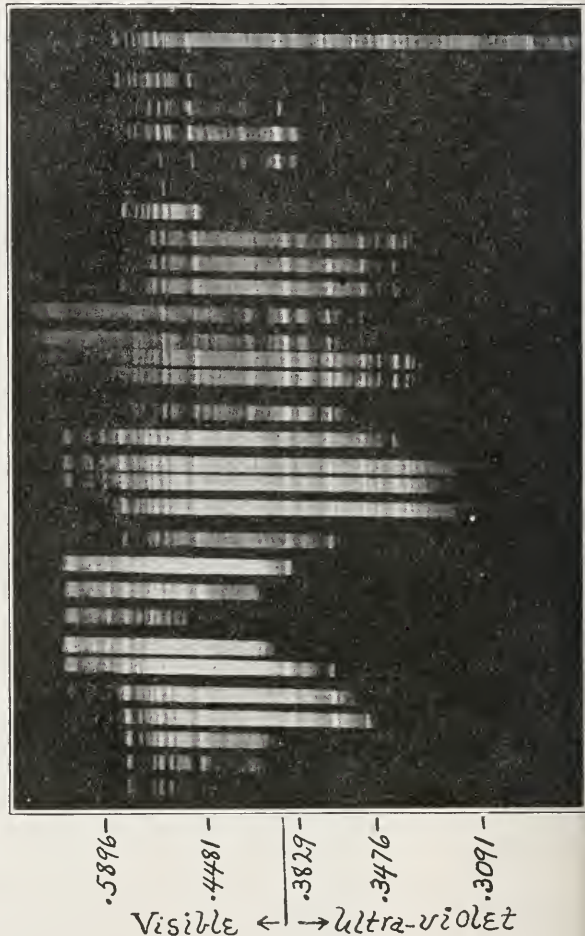


Fig. 18.—Transmission of various ophthalmic glasses in the visible and ultra-violet. Spectrographic record. (Permission of the *Journal of the Optical Society of America*.)

ambers and nactics, etc.) are entirely different in their transmission limits and hence in the amounts of various wavelength energy which they will transmit. The family of spectrograms labelled “Nactics” at the bottom of Figure 18 illustrates this point very nicely. Neither, in turn, can the relative limits of absorption be estimated in many cases by gradation of color of glass. In other words, coloring chemicals may often be added to glass without appreciably affecting the limit of transmission, as instanced by Crookes A and B shades, in

which the limit of transmission in the ultra-violet is virtually the same. And again, various samples of glass, all possessing the same color as judged by a matching of samples laid on a sheet of white paper, may vary considerably in their limits of transmission.

In 1914 Luckiesh presented a paper before the Illuminating Engineering Society (*Transactions of the Illuminating Eng. Soc.*, Vol. 9, 1914) on "Glasses for Protecting the Eyes." Luckiesh adopted the procedure of using the light from a quartz mercury arc reflected from a magnesia block. A series of exposures of equal length was made but with different known illuminations of the magnesia surface. Fol-

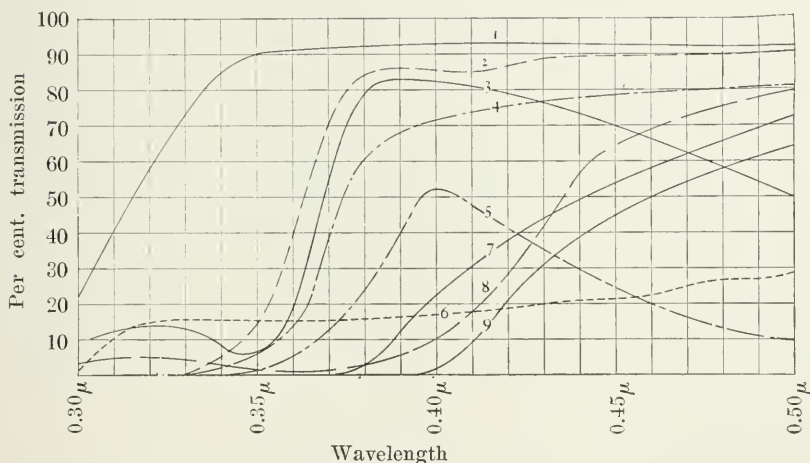


Fig. 19—Transmission of glasses in the region 3000 t. m. to 5000 t. m. (Courtesy of M. Luckiesh.)

- | | | |
|---------------------|----------------|-----------------|
| 1. Clear lead glass | 4. Light amber | 7. Medium amber |
| 2. D smoke | 5. 7 smoke | 8. Euphos |
| 3. Amethyst | 6. 6 smoke | 9. Akopos |

lowing these, exposures of the same length were made through the media to be examined with known illumination. The photographs were measured for density on a Martin's polarization photometer and curves were plotted between density and illumination for each line. From these curves the corresponding intensities of illumination (*i. e.*, transmission) were read off for each line of each negative exposed through the specimens. By taking into account the relative illuminations of the magnesia block the transmission at each wavelength was readily obtained. Figure 19 shows the transmission curves of various glasses in the region of 0.3μ to 0.5μ (3000 to 5000 t. m.). The curves are numbered and the glasses giving these transmissions are tabulated above the curves. Luckiesh says: "It will be noted that the trans-

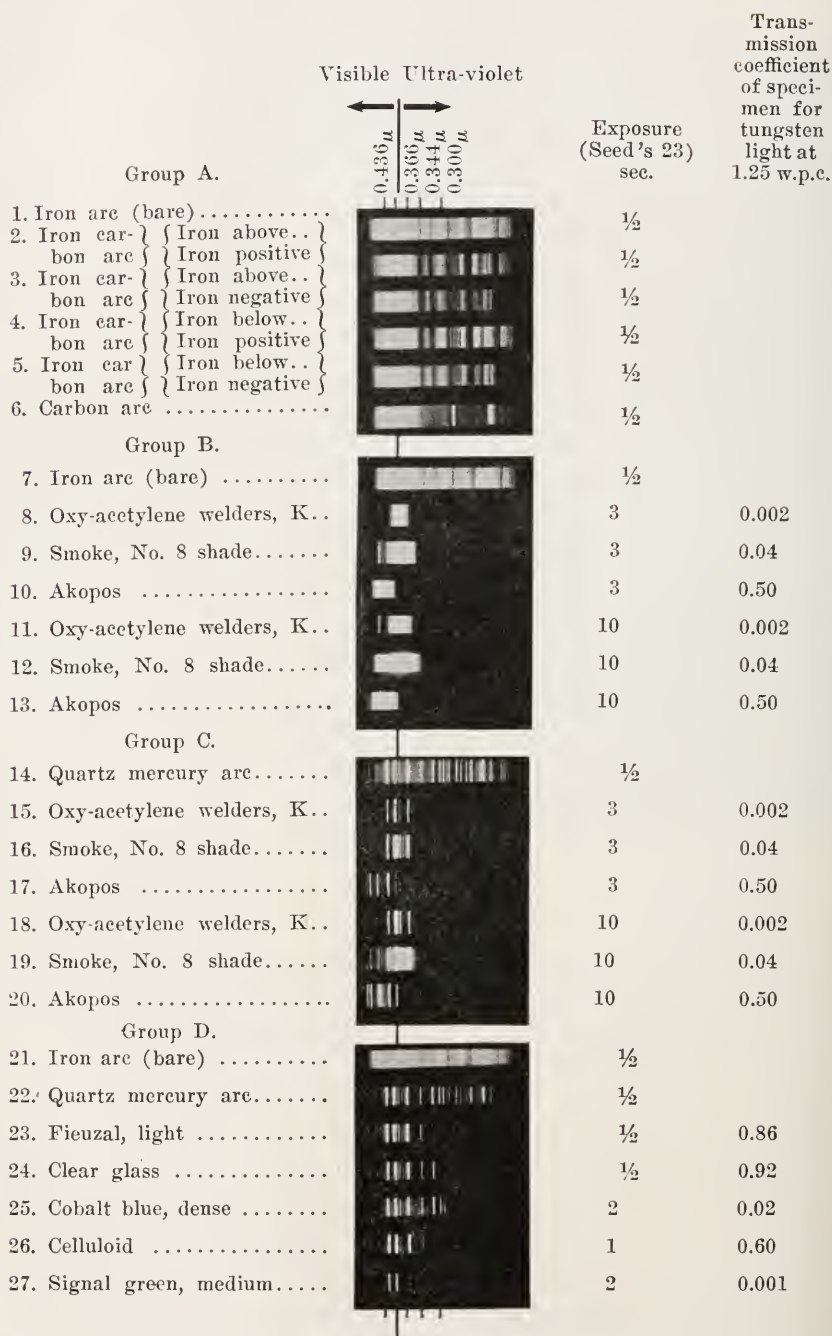


Fig. 20—Spectrograms of the transmission of various glasses in the ultraviolet.
(Courtesy of M. Luckiesh.)

	Visible ← | → Ultra-violet		
	0.436 μ 0.366 μ 0.344 μ 0.300 μ	Exposure (Lantern slide plate) sec.	Trans- mission coefficient of speci- men for tungsten light at 1.25 w.p.e.
Group E.			
28. Quartz mercury arc.....		1/2	
29. Clear glass, 1/16" thick....		1/2	0.92
30. Amber, medium, X.....		4	0.50
31. Kosma		1	0.83
32. Electric smoke		480	0+
33. Smoke X		3	0.015
Group F.			
34. Quartz mercury arc.....		1/2	
35. Amber, medium, X.....		15	0.50
36. Kosma		1/2	0.83
37. Smoke X		6	0.015
38. Euphos, 3/64" thick		8	0.81
39. Thermoscopic		1	0.86
Group G.			
40. Quartz mercury arc		1/2	
41. Distilled water (1 cm.)...		1/2	0.93
42. Clear glass, 1/16" thick....		1/2	0.92
43. Smoke A		1 1/2	0.36
44. Smoke C		2 1/2	0.20
45. Smoke A + C		7	0.07
Group H.			
46. Quartz mercury arc		1/2	
47. Euphos, 1/64" thick.....		1	0.90
48. Amber, light shade.....		3	0.67
49. Amber, medium shade....		6	0.45
50. Amber, medium, X.....		20	0.50
51. Smoke X		15	0.015

Fig. 21—Spectrograms of the transmission of various glasses in the ultraviolet.
(Courtesy of M. Luckiesh.)

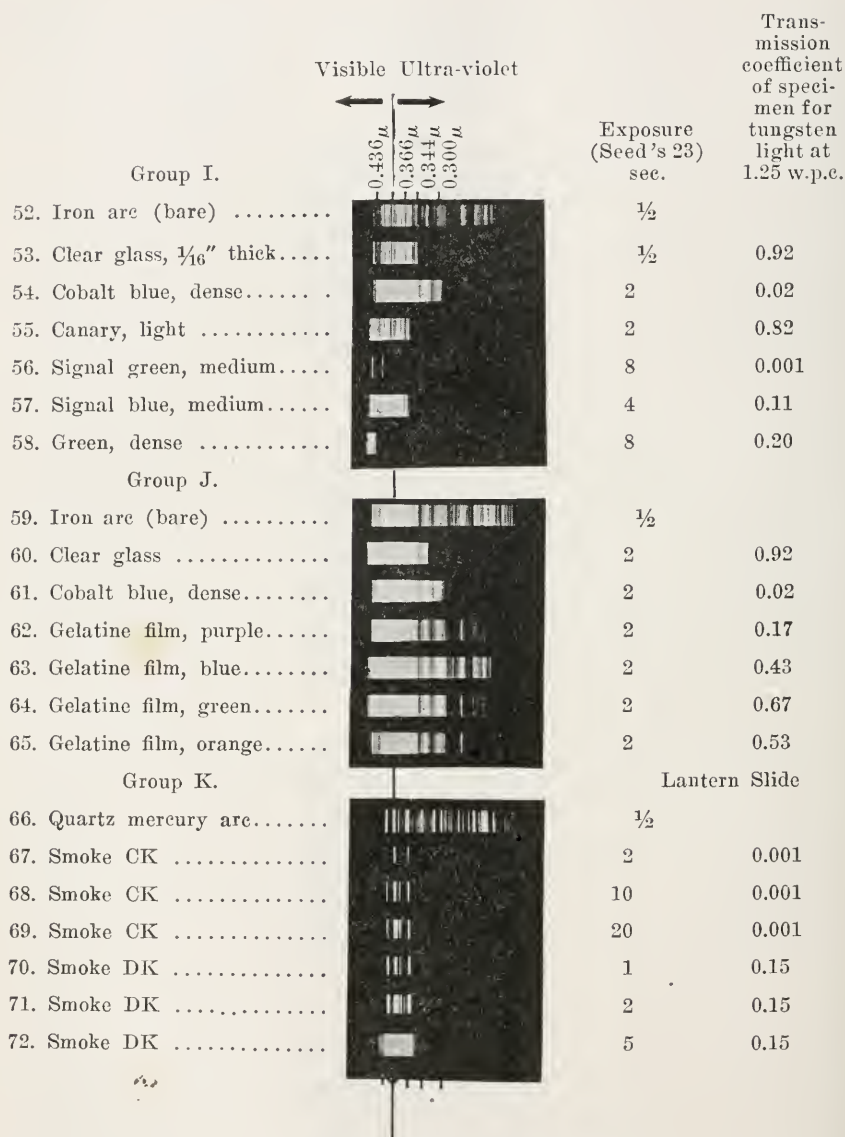


Fig. 22—Spectrograms of the transmission of various glasses in the ultraviolet.
(Courtesy of M. Luckiesh.)

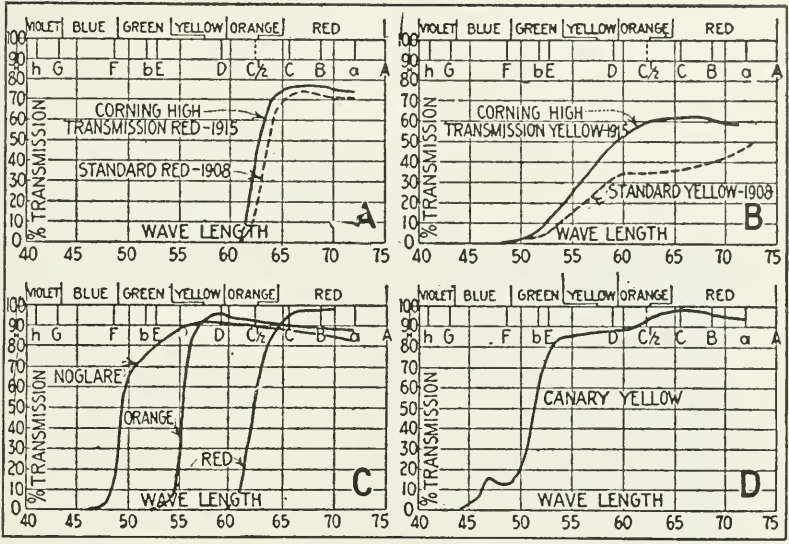


Fig. 23—Characteristic transmission curves for colored glasses. (From Gage: *Trans. Ill. Eng. Soc.*, Vol. XI, 1916.)

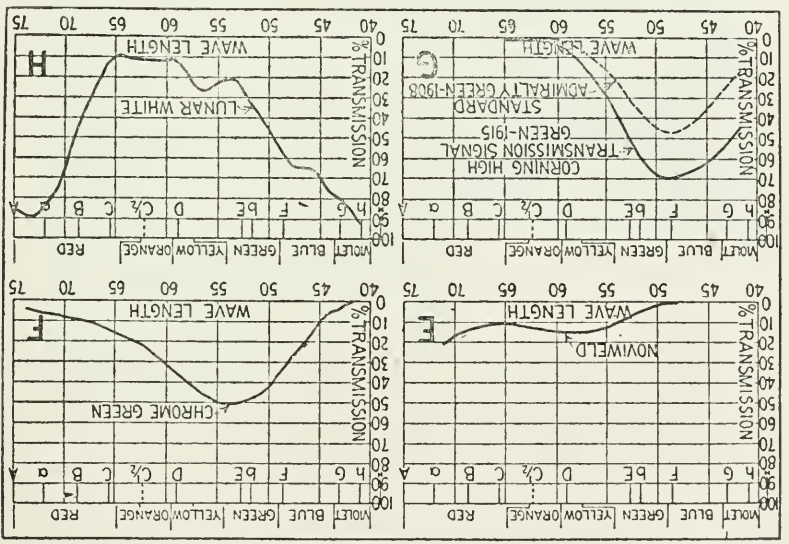


Fig. 24—Characteristic transmission curves for colored glasses. (After Gage: *Trans. Ill. Eng. Soc.*, Vol. XI, 1916.)

parency of clear lead glass remains unchanged to rays as short as 0.35μ . The smoke glasses are representative of many examined. They show little tendency to selectively absorb ultra-violet rays and differ considerably in their characteristics. These glasses cannot conscientiously be recommended with safety for the protection of the eyes against excessive ultra-violet radiation. The amethyst glass absorbs more ultra-violet than clear glass yet is transparent far into the ultra-



Fig. 1. Red

Fig. 2. Yellow

Fig. 3. Green

Fig. 4. Lunar white

Fig. 5. Blue

Fig. 25—Spectrograms of colored glasses used in railway signals. (After Gage: *Trans. Ill. Eng. Soc.*, Vol. XI, 1916.)

violet region. The amber glasses quite satisfactorily absorb ultra-violet rays but give rise to some objection from the standpoint of color. Several deep-red glasses were examined and all found to be opaque to ultra-violet rays but on account of the strong color should not be recommended. * * * The transmission of Euphos glass decreases considerably in the ultra-violet but shows a tendency to increase in transparency in the region 3200 t. m. This transparency to short wave ultra-violet rays becomes quite marked in less dense specimens."

Figures 20, 21 and 22 give a number of spectrograms published by Luckiesh illustrating the transparency of various media to rays of

different wavelength. The division line between the visible and ultra-violet is set at about 4000 to 3900 t. m. The seconds' exposure and the transmission coefficient for the total visible light from a tungsten lamp are indicated. "In group I and J," writes Luckiesh, "are the

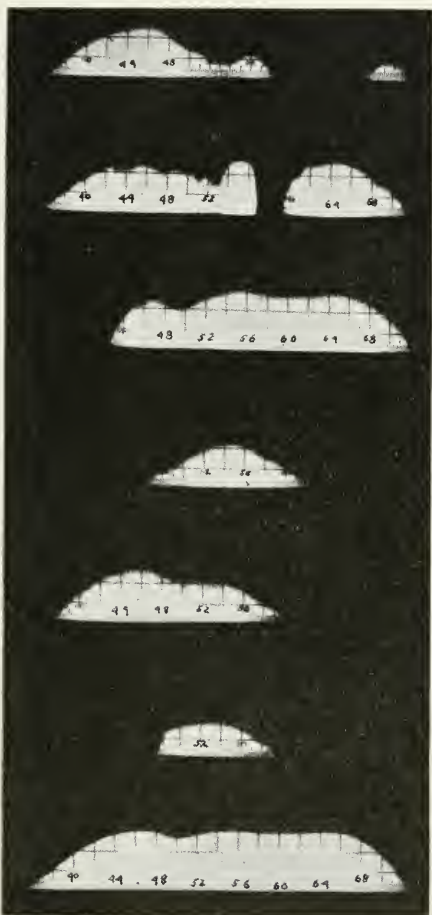


Fig. 1. Cobalt

Fig. 2. Didymium

Fig. 3. Uranium

Fig. 4. Chrome green

Fig. 5. Blue green

Fig. 6. Blue green plus noglare

Fig. 7. Clear

Fig. 26—Colored glasses exhibiting band spectra (Nos. 1 to 3). Green glasses (Nos. 4 to 6). (After Gage; *Trans. Ill. Eng. Soc.*, 1916.)

spectrograms of various common glasses which are often used in the industries. It is seen that the cobalt-blue glass is more transparent to ultra-violet radiation than is a clear glass of the same thickness. The clear glass used was a lantern-slide cover glass. This difference is best shown in 60 and 61 where the exposures were equal. It is signi-

ficant to note that the clear glass is approximately 46 times the more transparent to visible light than the cobalt-blue glass."

Figures 23-26 are taken from an article by Dr. H. P. Gage on "Colored Glass in Illuminating Engineering," (*Trans. Ill. Eng. Soc.*, Vol. XI, 1916). The first two of these diagrams give some characteristic curves of transmission in the visible regions by various colored glasses. Figure 25 gives reproduced spectrograms of the colored glasses commonly used in railway signals. Figure 26 is of interest in that it shows the effects of the addition of certain ingredients to white glass upon the transmissive properties of the product.

The transmission curves of a considerable number of neutral and colored glasses have been determined in the laboratories of the American Optical Company and published in a brochure entitled "*The Ophthalmic Use of Crookes Lenses*." These curves for clear glass, Crookes A and B, a couple of ambers, amethyst, smoke, etc., together with the data giving the approximate absorptions are shown in Figures 27-35, inclusive. It will be noted that the transmission in the visible spectrum for white glass is practically 92 per cent., the reflection from the surfaces amounting to about 8 per cent. The ultra-violet and near violet transmission is shown by shading in two different manners, that lying close to the violet (3900 to 3700 t. m. roughly), and that below 3700 t. m. The transmission for white glass becomes zero at about the 2800 t. m. point. It will also be noticed that the transmission in the ultra-violet is considerably greater than that of any of the other glasses shown. The Wellsworth Crookes A—after the formula of Sir William Crookes—is practically a colorless glass and yet the absorption of the ultra-violet in comparison to white glass is marked, absorbing as it does the ultra-violet completely below 3600 t. m. Another characteristic of both the Crookes A and B shades is the appreciable absorption of a selective character in the yellow region and just above the point generally specified as being the maximum of the sensibility curve of the average eye (5600 t. m.) under fairly high illuminations. The reader will likewise be interested in comparing these curves for Wellsworth Crookes lenses with determinations made at the Bureau of Standards by Gibson and McNicholas (Figure 36). And again, a comparison of Wellsworth Crookes A and B, either in the diagrams accompanying this discussion or in those given by Gibson and McNicholas, show that the limits of absorption in the ultra-violet of the two shades is the same and that the transmission curves are practically one and the same beyond 3700 t. m. Figure 36, by Gibson and McNicholas, gives the transmission curves of white glass, Crookes A Wellsworth, Crookes B Wellsworth side by side upon the same plat

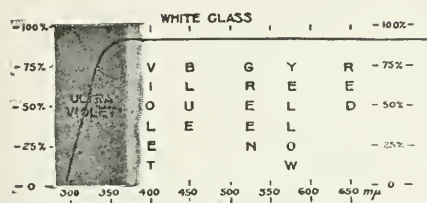


Fig. 27. White Glass.

Absorption of white optical glass used for spectacles for a thickness of 2 mm. is under 1/10%, throughout the visible spectrum. The transmission of a plano white lens is 91.8%. The reflection from the two surfaces is 8.2%.

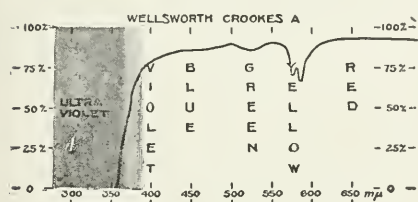


Fig. 28. Wellsworth Crookes "A"

The curve shows the percentage transmission of Crookes' "A" for various colors or wave-lengths of light (thickness 2 mm.).

The percentage of absorption for these different wave-lengths is as follows:

Limit-Red	1%	Blue	7%
Red	1	Violet	8
Yellow	15	Limit-Violet	15
Green	4		

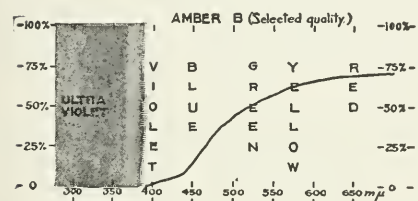


Fig. 29. Amber "B"—Selected Quality

The curve shows the percentage transmission of Amber (dark shade) for various colors and wave-lengths of light (thickness 2 mm.). The percentage of absorption for these different wave-lengths is as follows:

Limit-Red	20%	Blue	65%
Red	25	Violet	90
Yellow	30	Limit-Violet	95
Green	45		

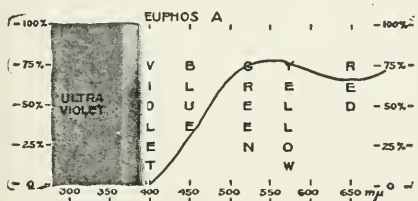


Fig. 30. Euphos "A"

The curve shows the percentage transmission of Euphos for various colors and wave-lengths of light.

The percentage of absorption for these different wave-lengths is as follows:

Limit-Red	20%	Blue	45%
Red	25	Violet	85
Yellow	15	Limit Violet	99
Green	15		

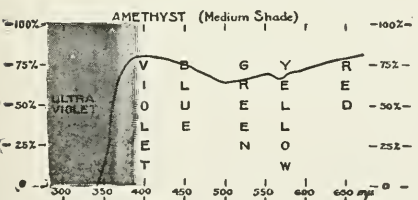


Fig. 31. Amethyst—Medium Shade.

The curve shows the percentage transmission of Amethyst (dark shade) for various colors and wave-lengths of light (thickness 2 mm.). The percentage of absorption for these different wave-lengths is as follows:

Limit-Red	10%	Blue	60%
Red	15	Violet	10
Yellow	20	Limit-Violet	8
Green	28		

Figs. 27-31—Percentage transmission of light by ophthalmic glasses. (From the American Optical Co.)

and this makes comparison easy. Another interesting comparison is that between Crookes B and Smoke B (*vide* Figures 32 and 35). In many respects these glasses are similar in their absorptions but there is one marked and noteworthy difference: the absorption of the ultra-

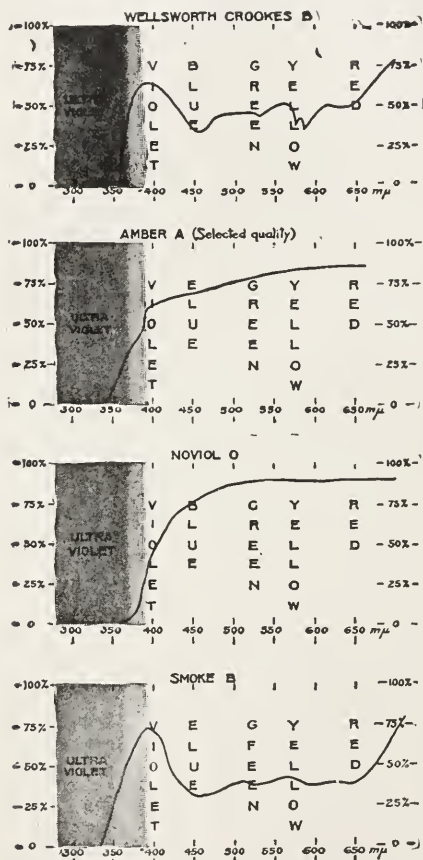


Fig. 32. Wellsworth Crookes "B"

The curve shows the percentage transmission of Crookes' "B" for various colors or wave-lengths of light (thickness 2 mm.). The percentage of absorption for these different wave-lengths is as follows:

Limit-Red 15%	Blue 50%
Red 35	Violet 30
Yellow 40	Limit-Violet 20
Green 40	

Fig. 33. Amber "A"—Selected Quality

The curve shows the percentage transmission of Amber (light shade) for various colors and wave-lengths of light (thickness 2 mm.).

The percentage of absorption for these different wave-lengths is as follows:

Limit-Red 5%	Blue 25%
Red 8	Violet 30
Yellow 10	Limit-Violet 40
Green 15	

Fig. 34. Noviol "O"

The curve shows the percentage transmission of Noviol "O" for various colors or wave-lengths of light (thickness 2 mm.).

The percentage of absorption for these different wave-lengths is as follows:

Limit-Red 1%	Blue 15%
Red 2	Violet 50
Yellow 4	Limit-Violet 75
Green 4	

Fig. 35. Smoke "B"

The curve shows the percentage transmission of Smoke (medium shade) for various colors and wave-lengths of light (thickness 2 mm.).

The percentage of absorption for these different wave-lengths is as follows:

Limit-Red 5%	Blue 55%
Red 10	Violet 40
Yellow 50	Limit-Violet 25
Green 50	

Figs. 32-35—Percentage transmission of light by ophthalmic glasses. (From the American Optical Co.)

violet by Crookes B is complete at slightly under 3600 t. m., while for the Smoke B the absorption is not complete until about 3200 t. m. is reached. There are many reasons for believing that the deleterious or, to say the least, non-desirable effects of the ultra-violet rays under ordinary, workaday conditions lie in the region just below 3600 t. m. Since smoke glass transmits these shorter ultra-violet rays it would appear fairly conclusive that the value of the use of Crookes, Smoke

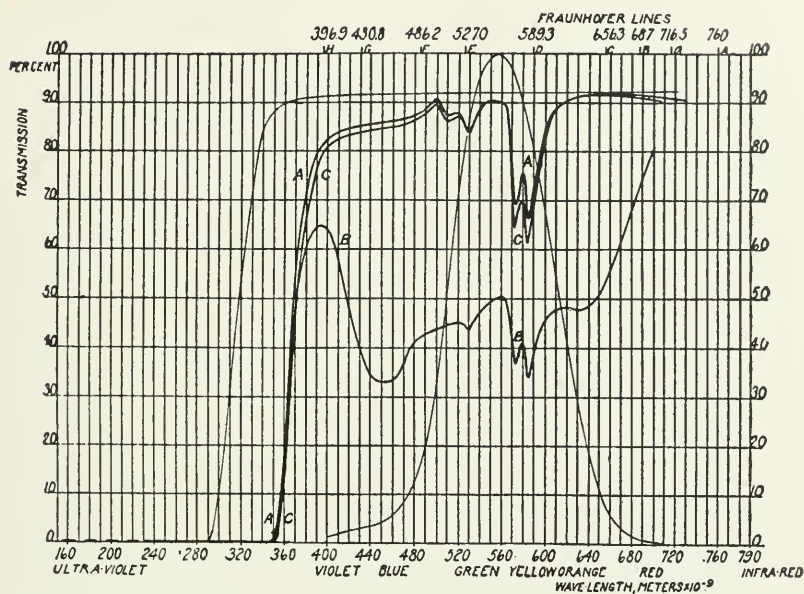


Fig. 36—A—"Crookes A, Wellsworth," 2.05 mm; B—"Crookes B, Wellsworth," 2.16 mm; A. O. Co. C—"91 B," 1.97 mm; Corning. (After Gibson and McNicholas. Permission of Bureau of Standards.)

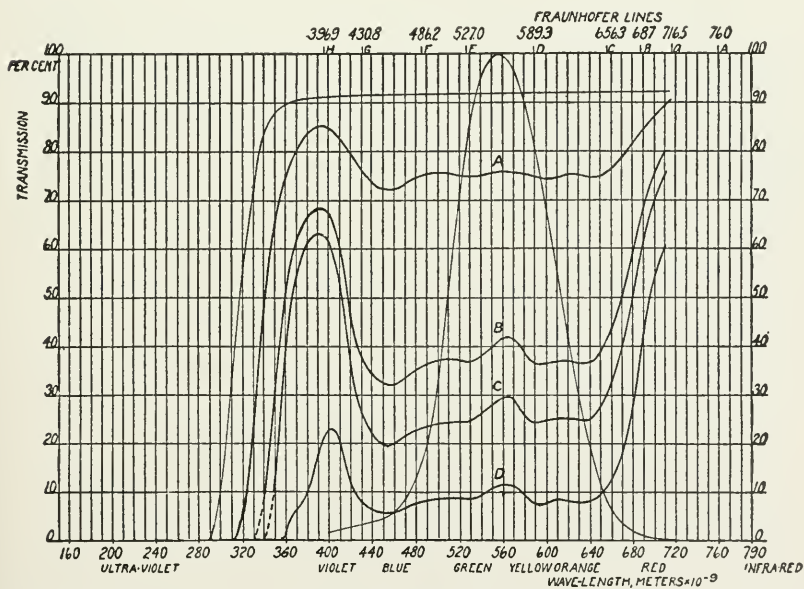


Fig. 37—A—"Smoke A," 2.10 mm; B—"Smoke B," 2.14 mm; C—"Smoke C," 2.13 mm; D—"Smoke D," 2.03 mm; A. O. Co. (After Gibson and McNicholas. Permission of Bureau of Standards.)

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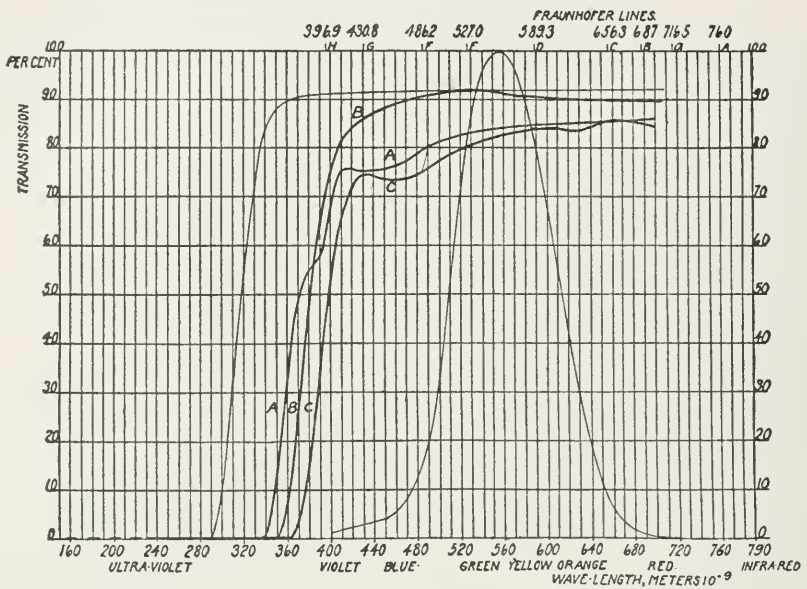


Fig. 38—A=“Luxfel,” 2.00 mm; B=“Lab. No. 57,” 1.90 mm; C=“Lab. No. 58,” 2.02 mm; A. O. Co. (After Gibson and McNicholas. Permission of Bureau of Standards.)

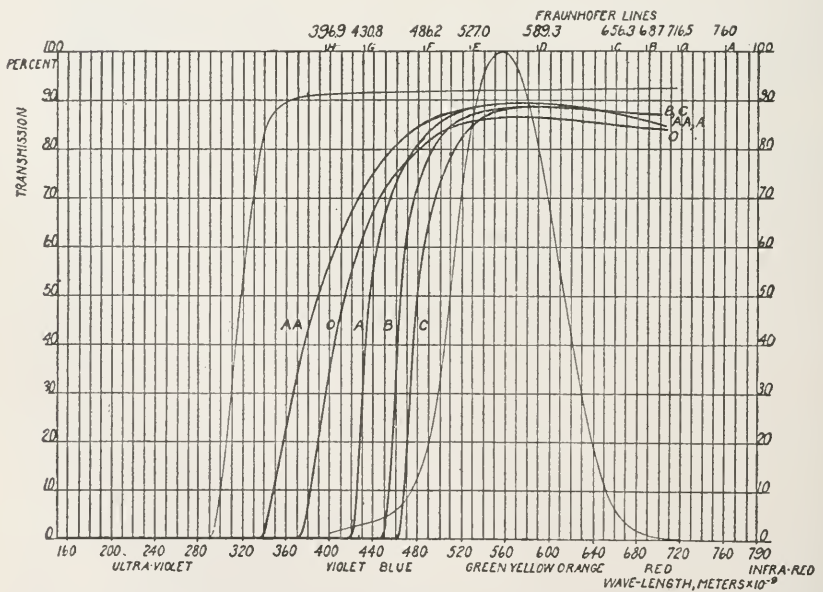


Fig. 39—AA=“Noviol AA,” 1.88 mm; O=“Noviol O,” 2.03 mm; A=“Noviol A,” 2.06 mm; B=“Noviol B,” 2.10 mm; C=“Noviol C,” 2.10 mm; A. O. Co. (Permission of Bureau of Standards.)

or similar glasses lies in the reduction of the total quantity of energy entering the eye. A comparison of the data of the curves given in Figures 36 and 37 will emphasize these points of similarity and dissimilarity. Amber A (Fig. 33), Amber B (Fig. 29) and Noviol O (Fig. 34) may properly be grouped in a family for the purposes of discussion. All of these (and other glasses such as Nactic, Luxfel, Oliveye, etc.) possess in general a yellowish or yellowish-green hue. The Noviol O, of all those specified, has the least effect upon the visible

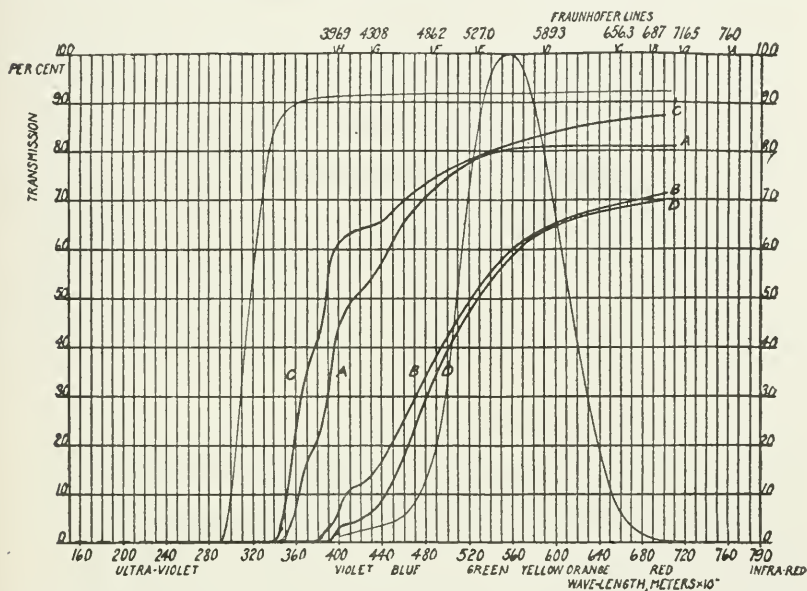


Fig. 40—A=“Amber A,” 2.13 mm; B=“Amber B,” 2.13 mm; A. O. Co. C=“Amber, light,” 1.93 mm; D=“Amber, dark,” 1.85 mm; W. & O. (Permission of Bureau of Standards.)

spectrum, since it transmits about 85 per cent. of all wavelengths from the red at 7200 t. m. down to the green-blue at 5000 t. m. The amber A (selected quality, Fig. 33) transmits considerably more ultra-violet than does the Noviol. In turn, however, the amber B absorbs all the ultra-violet beyond 3800-3900 t. m. and has much more marked absorptive effects in the violet, blue and green than either Noviol or the lighter ambers. The transmission curves for Euphos, Fieuzal, Chlorophyl, Hallauer, Akopos, Saniweld, and special glasses such as “392 F,” “124 J. A.” etc., and the Pfund gold film between plates of Crookes glass are given in Figures 41 to 44.

Reference has already been made to the work of Gibson and McNicholas on the Ultra-violet and Visible Transmission of Eye-Pro-

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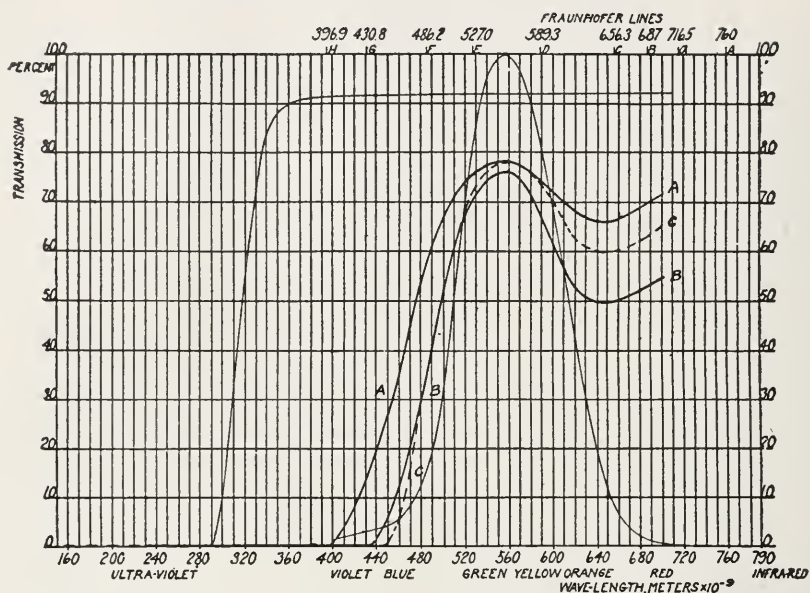


Fig. 41—A="Euphos," 1.95 mm; B="Lab. No. 61," 2.13 mm; A. O. Co. C=glass labeled "Fieuzal," bought in store. (Permission of Bureau of Standards.)

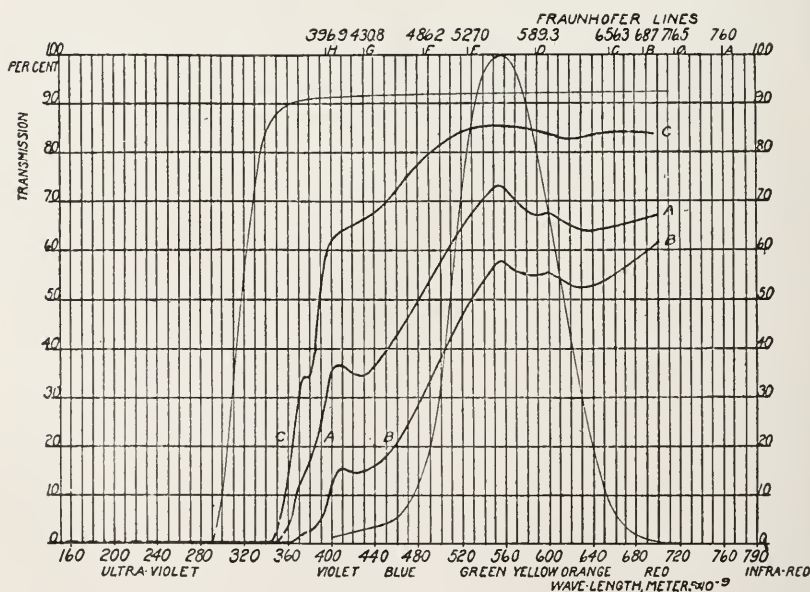


Fig. 42—A="Fieuzal A," 2.13 mm; B="Fieuzal B," 2.13 mm; A. O. Co. C="Fieuzal," 1.98 mm, W. & O. (Permission of Bureau of Standards.)

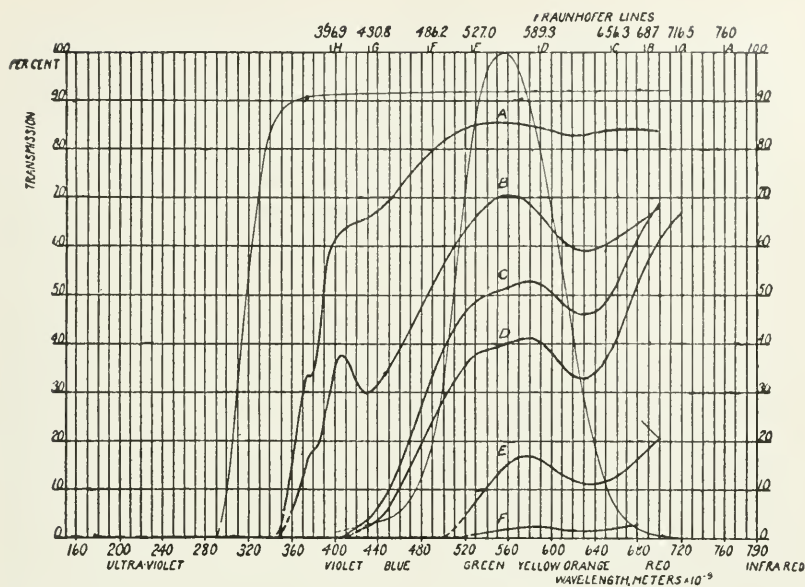


Fig. 43—A=“Fieuzal,” 1.98 mm; B=“Chlorophyll,” 1.98 mm; C=“Hal-lauer,” 1.90 mm; W. & O. D=“Akopos,” 2.17 mm; E=“Saniweld, light,” 1.82 mm; F=“Saniweld, dark,” 2.12 mm (see Fig. 21); King. (Permission of Bureau of Standards.)

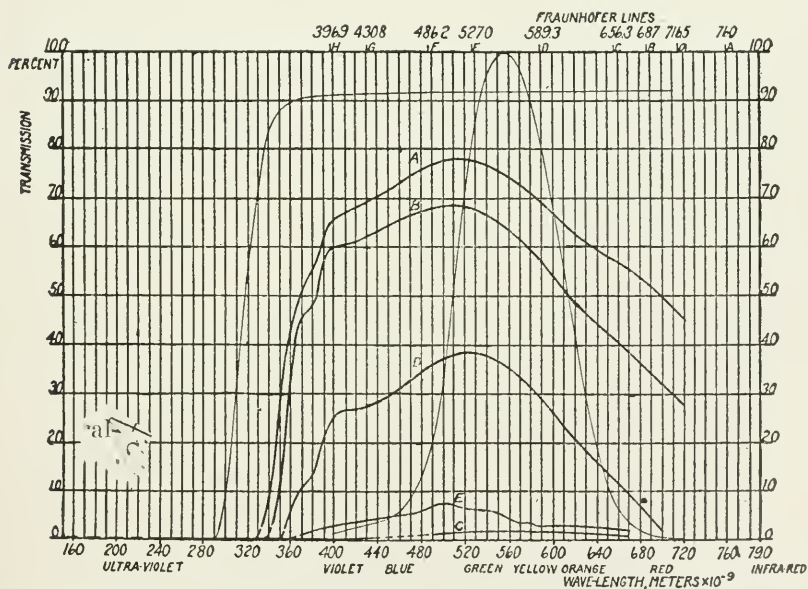


Fig. 44—A=“392 F,” 1.90 mm; B=“124 JA,” 2.02 mm; C=“124 IP,” 2.00 mm (see Fig. 21); Corning. D=“Lab. No. 59,” 2.13 mm; E=“Pfund,” gold film between plates of “Crookes” glass, total 2.89 mm; A. O. Co. (Permission of Bureau of Standards.)

teetive Glasses. This appeared as one of the *Technologic Papers of the Bureau of Standards* in 1919, (No. 119). Without doubt it is the most exhaustive study of the subject yet made. For details of the experimental procedure and for the methods they devised of computing the transmission for different thicknesses of glass, the reader is referred to the original paper. Figures 36 to 47 inclusive are taken from the paper by Gibson and McNicholas and are self-explanatory. In commenting upon the results of their investigations these men

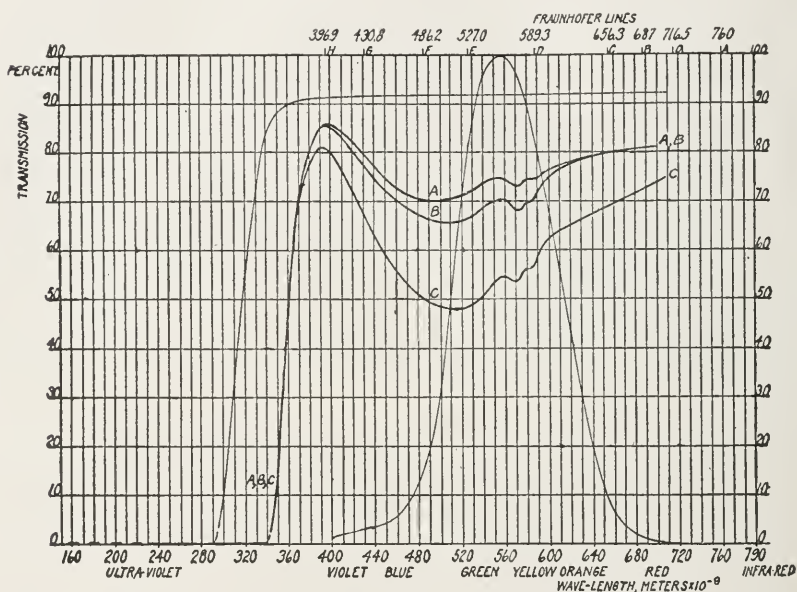


Fig. 45—A="Amethyst A," 2.08 mm; B="Amethyst B," 2.05 mm; C="Amethyst C," 2.04 mm; A. O. Co. (Permission of Bureau of Standards.)

write: "Of the specimens studied, the five kinds which are most efficient as protection against the ultra-violet, while being at the same time nearly colorless in the thicknesses examined, are 'Crookes A,' Corning '91 B,' A. O. Co. Lab. 'No. 57,' A. O. Co. Lab. 'No. 58,' and 'Noviol O.' Of these, 'Noviol O' and A. O. Co. 'Lab. No. 58' are the best, but are not so truly colorless as the other three. Of the slightly colored glasses, by far the best seem to be 'Noviol A' and 'Noviol A₁' as they absorb completely below 410 mμ. while transmitting about 87 per cent. of the incident light. It is not thought that the slight color would be at all objectionable for ordinary use. A combination of 'Noviol A' and Corning '124JA' is very efficient for eye protection, as it absorbs all the ultra-violet and most of the infra-

red, and still has high visible transmission. The color is a very light green and the colors of objects viewed through it are distorted practically none at all. A gold film on 'Noviol A' glass would also be very efficient, though transmitting less of the visible than the combination just mentioned. The yellow and yellow-green glasses of a deeper shade are usually good protection against the ultra-violet. The green and blue-green glasses of Fig. 44 are used primarily to protect the eye from the infra-red. The 'Pfund' specimen is a gold

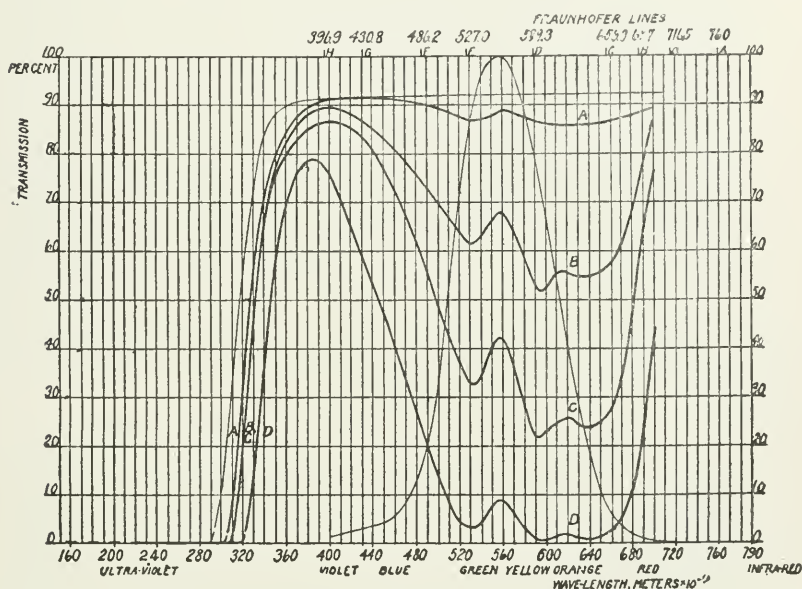


Fig. 46—A=“Blue A,” 2.10 mm; B=“Blue B,” 2.04 mm; C=“Blue C,” 2.05 mm; D=“Blue D,” 2.11 mm; A. O. Co. (Permission of Bureau of Standards.)

film between two pieces of what seems to be ‘Crookes’ glass. ‘Smoke,’ amethyst and blue or purple glasses are liable to be little better than clear glass as a protection against the ultra-violet. Of the welding glasses, yellow seems to be the safest, as the green or neutral shades are liable to have transmission bands centering near $395 \text{ m}\mu$, which may extend to a considerable distance into the ultra-violet.

Gibson and McNicholas also investigated the transmissions of a few glasses which may be classed as welding glasses. These glasses are for use under high powered arcs and chiefly in industries in which welding enters. Figures 48, 49 and 50 give the graphical results in the ultra-violet and visible of several kinds of special welding glasses.

TRANSMISSION OF RADIANT ENERGY

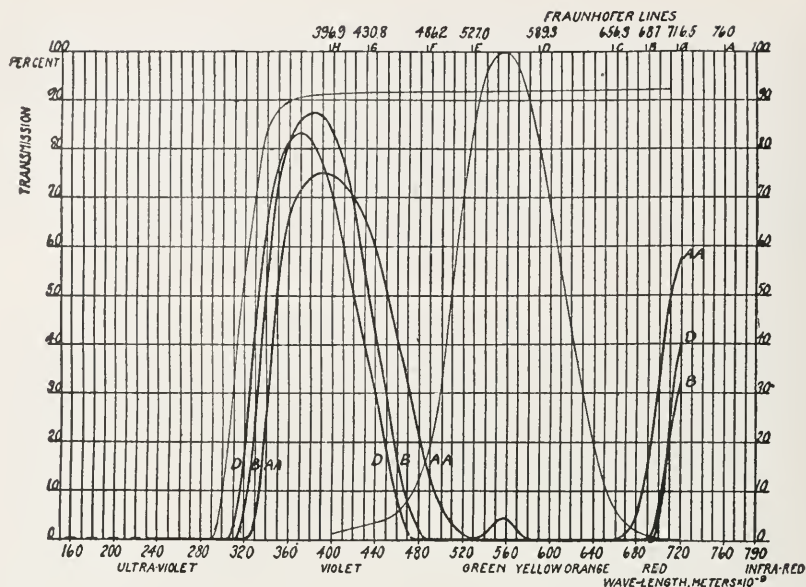


Fig. 47—AA="Cobalt Blue AA," 2.75 mm; B="Cobalt Blue B," 1.85 mm; D="Cobalt Blue D," 1.86 mm; "Cobalt Blue A," 3.20 mm nearly same as curve AA; "Cobalt Blue C," 1.46 mm nearly same as curve B; "Chromatic Test," 2.36 mm similar to curve B, but slightly lower in value; A. O. Co. (Permission of Bureau of Standards.)

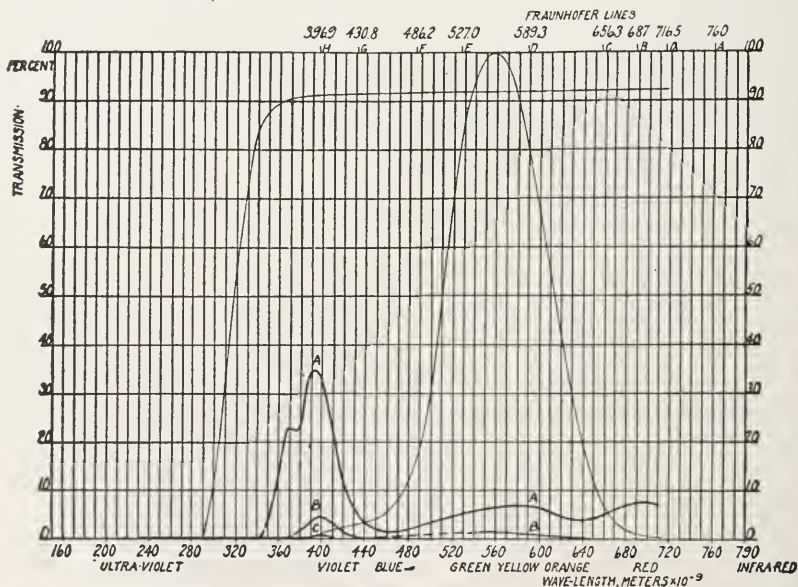


Fig. 48—A="Welders Smoke Dark," 1.42 mm; B="Special Welders Light," 1.68 mm (see Fig. 21); C="Special Welders Dark," 2.54 mm (see Fig. 21); A. O. Co. (Permission of Bureau of Standards.)

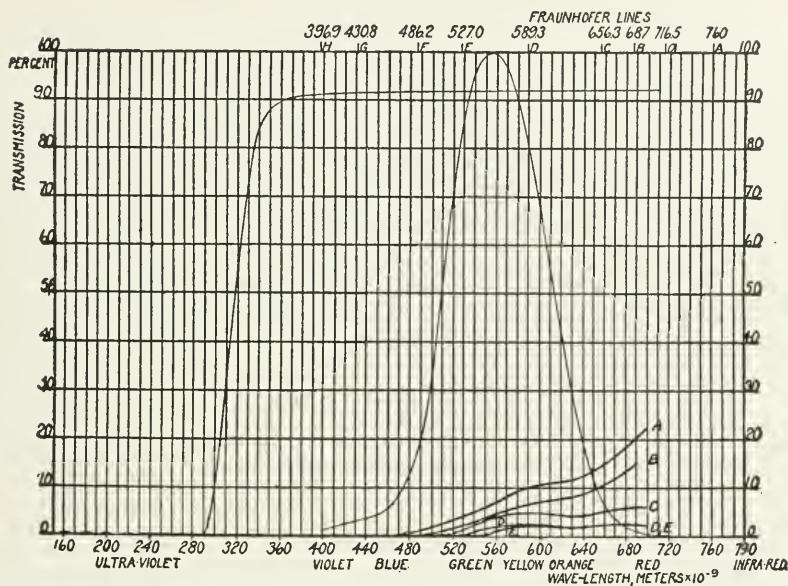


Fig. 49—A=“Welding glass 6,” 1.97 mm; B=“Welding glass 2,” 2.32 mm; C. E. S. Co. C=“Noviweld 4,” 1.89 mm; D=“Noviweld 5,” 2.16 mm; E=“Noviweld 6,” 2.20 mm; “Noviweld 7,” 1.90 mm 1.02% at 578; “Noviweld 8,” 2.01 mm 0.517% at 578; A. O. Co. (Permission of Bureau of Standards.)

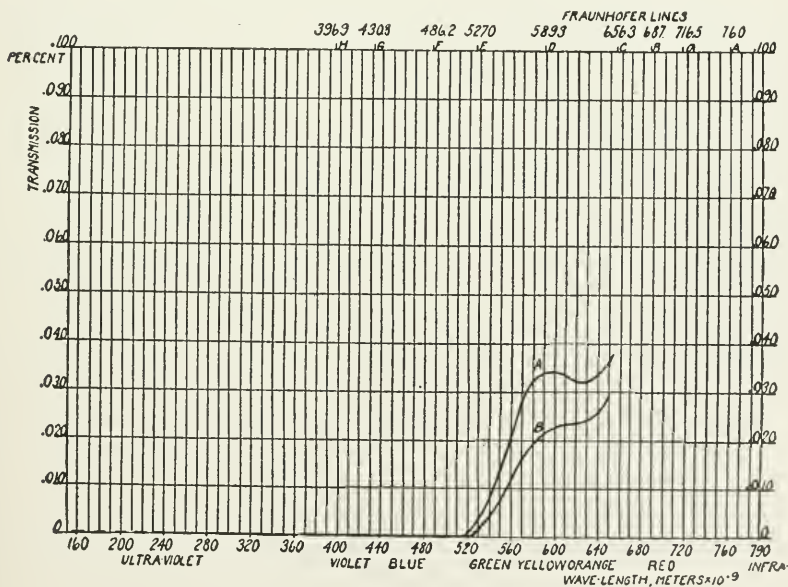


Fig. 50—Note scale of ordinates. A=“Special Noviweld No. 8,” 1.77 mm; Hardy. B=“391 DD,” 1.90 mm; Corning. (Permission of Bureau of Standards.)

The extremely small percentage (about 0.03 per cent.) of transmission in the yellow-green region for the special Noviwelds shown in Figure 50 is worthy of notice.

One criticism which it seems to the writer may be passed upon the work of Gibson and McNicholas is that, in the majority of their tests, transmission measures in the ultra-violet were not carried further than 2 per cent. With low incident energy or brief times of exposure this small amount of transmission in the extreme ultra-violet obtained with glasses, etc., might be neglected, but this low percentage transmission may still be extremely important under conditions imposed by welding operations and so forth.

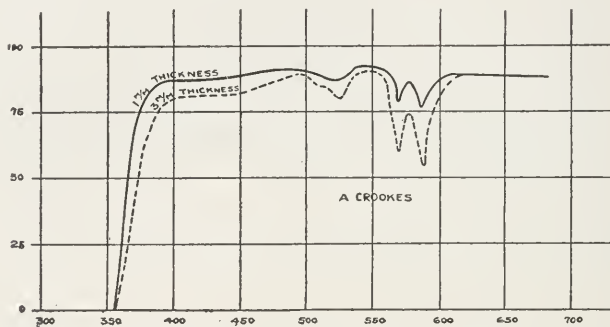


Fig. 51—Effect of thickness on transmission of Wellsworth Crookes glass.
(Permission of the American Optical Company.)

In all of these later experiments upon the transmission of glass due care has been taken to have all the results reduced to a uniform basis; i. e., the element of variation of thickness of sample of glass has been eliminated. It is of interest, therefore, to see what effects thickness has upon the transmission of glass having thicknesses found in ophthalmic lenses. An article by Sheard on the Effect of the Thickness of Glass upon the Transmission of Various Parts of the Spectrum (*Wellsworth*, page 140, 1919) gives the results upon Crookes A, Noviol O, Smoke B and Fieuzal A. Every lens other than a plano has a thickness varying from the center to the edge. In the case of convex lenses, the thickness increases toward the position of the optical center: in concave lenses just the reverse is true. Hence, a high-powered plus lens may be several millimeters in thickness at the optical center, while a concave lens may be almost as thin as a sheet of paper at the center point. It necessarily follows, therefore, that the tint of a lens cannot be preserved uniformly over the surface of lenses having appreciable power. An amber lens, for example, becomes

lighter and the color fades out at the thinner portions of the finished lens, although the original glass block from which the lens was manufactured was of uniform color or tint throughout. As a result therefore, the color and the percentage of transmitted light of various wavelengths vary. There is, possibly, one method which would annul such effects and that is the scheme of applying the tint, somewhat after the manner of a coat of paint, to the surfaces of the lenses after they are finished. But no satisfactory device has yet been discovered which will give the effect and the durability needed. And it is to be seriously doubted whether this process of coating lenses with desired colors, even if discovered, would obviate the changes

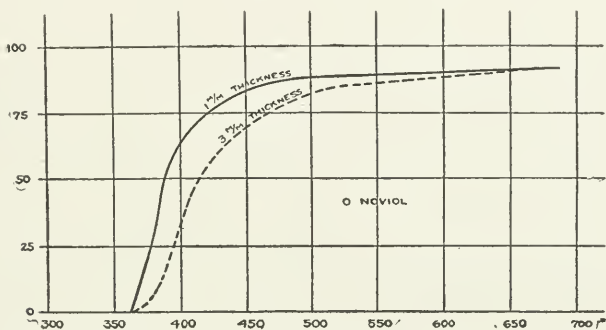


Fig. 52—Effect of thickness on the transmission of Noviol O. (From the American Optical Company.)

in shade or tint, since the same fundamental problem of absorption of glass as dependent upon its thickness would again enter.

The four sets of curves given in Figures 51-54 were determined in the Research Laboratories of the American Optical Company. They are given as typical curves illustrative of the effects of glass upon the transmission of spectral energy from the red down through and including the ultra-violet. In each of these diagrams the upper curves represent the transmission through one centimeter of glass and the lower curves give the results when the thickness of glass is of the order of three millimeters.

The curves show that a change of thickness from 1mm. to 3 mms. has but little effect upon the transmission of the visual and the ultra-violet radiations in the case of Crookes A and Noviol O. The greatest effect of thickness in Crookes A lies in the yellow-green region (5500 to 6000 Angstroms) where the absorption in the two characteristic bands is increased almost 25 per cent. The average effect of tripling the thickness is about 10 per cent. in the green to ultra-violet regions

inclusive. Hence, the most marked effect of change of thickness in Crookes A lies in the increased absorption in the yellow-green region; i. e., the region of maximum visibility of the human eye. Furthermore, the change in tint due to varying thicknesses of glass in the finished product is practically negligible with Crookes A and Noviol O.

Noviol O shows considerable increase (about 15 per cent.) in the absorption of the short wavelengths as the thickness is changed from 1 mm. to 3 mms. Thickness of glass has but little effect upon the transmission of the yellowish-green, yellow, orange and red radiations in the case of Noviol O. Hence this glass, by increased thickness, cuts down the percentage transmission of the green, blue, violet

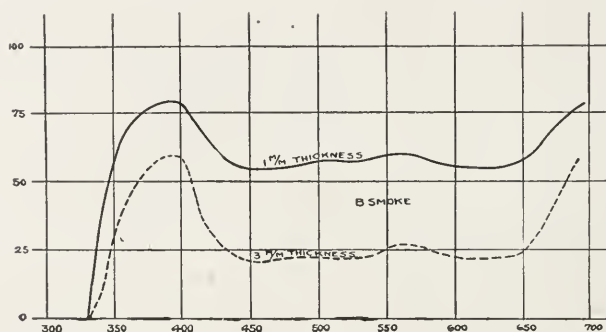


Fig. 53—Effect of thickness on the transmission of B Smoke. (From the American Optical Company.)

and ultra-violet without appreciably affecting the transmission of energy lying in the region of maximum visibility.

The data on Smoke B and Fieuzal A, as plotted in Figures 53 and 54, speak for themselves. In the case of Smoke B, in the region from 6500 to 4500 Angstroms approximately, a change of thickness from 1 mm. to 3 mms. changes the transmission from 50-60 per cent. to 20-25 per cent. The effect of thickness is less marked in the ultra-violet regions. It follows, therefore, that thickness has a marked effect upon the transmission throughout the whole of the visual spectral region.

Fieuzal A shows that the effects of thickness are pronounced, especially in the region from 5500 to 4000 Angstroms. Here again the percentage transmission is cut in half by a change of thickness from 1 mm. to 3 mms. of glass.

The general conclusion which may be drawn from these curves is: Appreciable changes in thickness—as judged from the standpoint of ophthalmic lens manufacture—may occur in lenses and prisms made

from Crookes A and Noviol O without any marked change in the percentages of various kinds of radiant energy transmitted by these glasses. Hence, they are nearly as effective in their transmissive and absorptive powers when made up in lenses having thicknesses up to 1 mm. as when these thicknesses are of the order of 3 mms. As a result, we are led to conclude that concave or convex lenses of high powers will have, when made up in Crookes A and Noviol O, practically the same effect upon the character of the luminous energy ultimately reaching the retina. Therefore, thicknesses commonly used in ophthalmic lens manufacture will not cause any noticeable

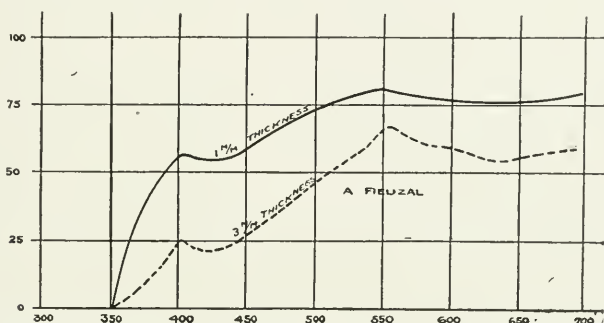


Fig. 54—Effect of thickness on the transmission of A Fieuzal. (Permission of the American Optical Company.)

variation in the tint or affect the transmission in appreciable amounts if either Crookes A or Noviol O is used.

The Infra-Red.

The fact that glassblowers are subject to a special form of cataract has raised the question as to whether or not this action is due to radiant energy and if so, whether this action is of an abiotic or thermic nature or whether it is caused by ultra-violet or infra-red radiations. Meyhofer in 1886 examined over five hundred glassmakers and found about 12 per cent. affected with cataract. The cataract almost always appears first in the left eye which is the more exposed to the energy from the molten glass. When appearing in the right eye first Stein showed that the glassblower had the habit of turning that side of the face toward the oven. The length of time necessary for development of the cataract is not exactly known but evidently comprises several years. The workmen also develop a peculiar rusty-brown spot on each cheek, generally more noticeable on the left. Hirschberg states that for over one hundred years it has been known that individuals exposed to intense heat and light are especially liable to cataract. In

the case of the glassblowers, the cataract begins as a rosette-like or diffuse opacity in the cortex at the posterior pole of the lens. Later, striae similar to those of senile cataract may appear. The great frequency, therefore, with which glassblower's cataract occurs, its relatively uniform character, and the fact that it occurs first in the more exposed eye argues for the statement that the cataract is due to radiant energy on the eye itself. The further questions as to whether the cataract is due to the direct action of the light upon the lens or upon the eye as a whole, and whether it is due to abiotic or thermic action are not so easily answered. Cramer, Stein and others believe that cataract is due to the chemical action of the ultra-violet; Vogt regards the infra-red as chiefly responsible.

The character of the radiation from molten glass is well known. It is that of an incandescent body of about 1200° to 1400° C. Crookes (*Trans. Royal Soc. Lon.*, 1914) says: "As far as one can judge the temperature at the melting end is about 1500° C. and at the working end decidedly less—say 1200° C." It is certain that the spectrum of a non-gaseous body at this temperature does not include any of the so-called abiotic radiation since the extreme limit of the spectrum of molten glasses as found by investigators is 3200 t. m., and estimates range from that up to 3350 t. m. Crookes (*l. c.*) made six exposures, as reported in his paper, with different times of exposure and found that the spectrum extended to 4520 t. m. after twenty minutes' exposure and from that time of exposure on, the limit of spectrum in the ultra-violet increased to 3345 t. m. after one hundred and eighty minutes' exposure. Certain it is that an exposure of three hours does not permit of the presence of much ultra-violet radiation. Also, without doubt, abiotic action cannot be traced beyond about 3100 t. m. Furthermore, the radiation of a body at such temperatures is relatively weak all through the ultra-violet (*vide* Figure 4). The maximum, according to Planck's and Wein's laws, for a body at 1300° C. lies far in the infra-red, while the energy in the whole visible and ultra-violet part of the spectrum is less than one per cent. of the total. Hence, to ascribe injurious effects to the visible or ultra-violet radiations without the elimination of the 99 per cent. of infra-red radiation would be, on its face at least, to lose all sense of the possible correlation of cause and effect.

These possible thermal effects on the eyes and this abundance of infra-red radiation are of significance in those who engage in such vocations as glassblowing and industries in which welding under powerful arcs is common. We are not desirous at this point of entering into an account of the various arguments and experiments for

and against the view that the infra-red radiations produce deleterious actions upon the eye: we shall simply give the results of various investigators as to the absorption by various glasses in the infra-red.

Sir William Crookes appears to have been the first to systematically engage in the development of glasses highly absorptive in the infra-red. His experimentation was carried on in connection with the Glass Workers Cataract Committee of the Royal Society, and consisted in the finding of the effects upon the ultra-violet, the visible and the infra-red of the addition of small quantities of metals such as cerium, chromium, cobalt, copper, iron, lead, manganese, uranium, neodymium, and so forth, to the raw soda flux. He developed a glass No. 246, consisting of 90 per cent. raw soda flux, 10 per cent. ferrous oxalate (a small quantity of red tartar and powdered wood charcoal was added to prevent oxidation) of a sage-green in color which cut off ultra-violet down to 3800 t. m., gave a heat absorption of 98 per cent. and transmitted 27.6 per cent. of the incident light. Another glass, No. 217, prepared from fused soda flux 96.8 per cent., ferrosiferrous oxide 2.85 per cent. and carbon 0.35 per cent., was found to cut off the ultra-violet below 3550 t. m., to cut off 96 per cent. of the heat radiation and to transmit 40 per cent. of the light.

In 1917 W. W. Coblentz and W. B. Emerson of the Bureau of Standards issued a paper on Glasses for Protecting the Eyes from Injurious Radiations (*Technologic Papers, Bureau of Standards*, No. 93). This paper deals largely with the protective properties of glasses which shield the eye from infra-red rays. In order to discuss their results we shall follow their sub-divisions of subject matter according to the color of the glasses. The figures and diagrams accompanying this discussion are from the paper of Coblentz and Emerson.

Curve A (Figure 55) shows the transmission of energy by the human eye. From this transmission curve it will be noticed that radiations of wavelength greater than 1.4μ cannot reach the retina. In fact, because of the presence of water, which is very opaque to infra-red rays, but little radiation of wavelengths greater than 1.5μ passes through the cornea. The cornea is about 0.6 mm. thickness. From this it will be noted that about 97 per cent. of the energy radiated from a furnace at 1000° to 1200° C. (*vide* Curve B, Figure 57) is absorbed in the outer portion of the eye.

Yellow-colored glasses. Curve B, Figure 55, gives the transmission of a Noviol glass, curve C that of an orange and curve D that of a canary glass all of 2 mm. thickness. Curve E is that of a colorless (or white) glass. The obstruction of these yellow glasses is but little greater than that caused by an equal thickness of colorless glass.

TRANSMISSION OF RADIANT ENERGY

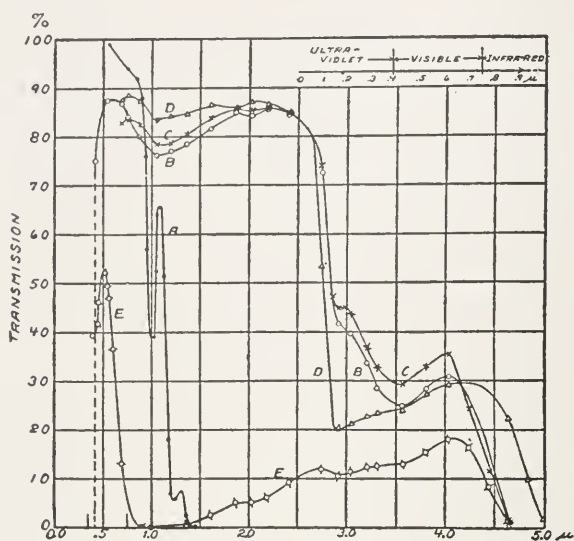


Fig. 55—A, human eye, Corning noviol glasses; B, yellow (thickness, $t=2.05$ mm); C, orange ($t=2.03$ mm); D, canary ($t=1.85$ mm); E, Corning G 124 JA, blue-green ($t=1.5$ mm). (After Coblenz and Emerson. Permission of Bureau of Standards.)

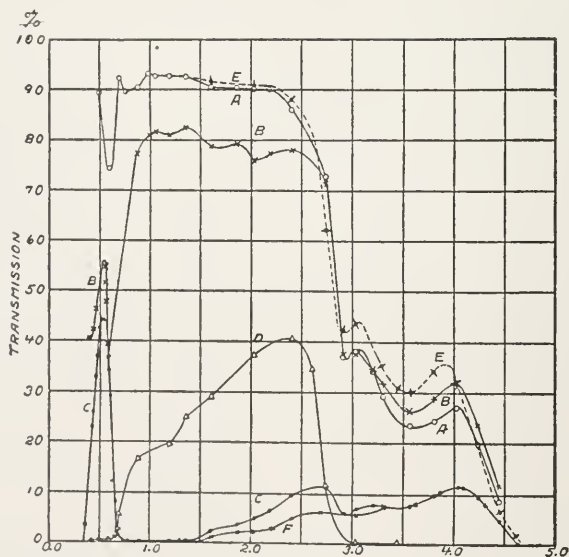


Fig. 56—Crookes's glasses; A, light ($t=1.96$ mm); B, dark ($t=2.00$ mm); C, ferrous No. 30, sage-green ($t=1.98$ mm). D, Schott's black glass ($t=3.6$ mm). E, white crown glass ($t=2.18$ mm). F, blue-green glass (A. O. C. Lab. No. 59; $t=1.93$ mm). (A and B are Crookes's neutral-tint glasses.) (After Coblenz and Emerson. Permission of Bureau of Standards.)

The amount of infra-red transmitted by such a glass as Noviol is about 55 per cent. of the total radiation from a furnace heated to 1000° to 1100° C.

Crookes's glasses. Figure 56 gives the transmission curves for a family of Crookes glasses. The lighter or neutral shades absorb but

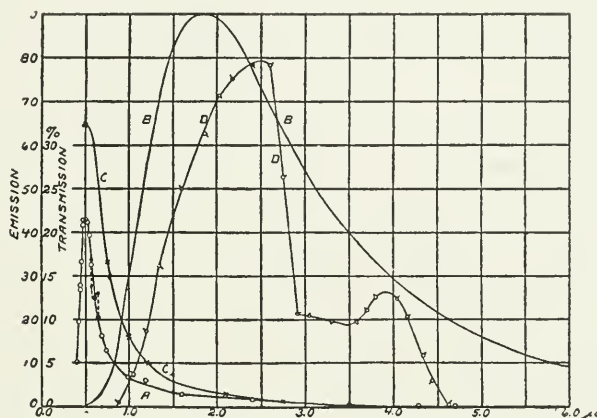


Fig. 57—A, C, gold glass; B, emission of black body (1050° C); D, electric smoke (red) [ordinates=emission scale] ($t=2.52$ mm). (Permission of Bureau of Standards.)

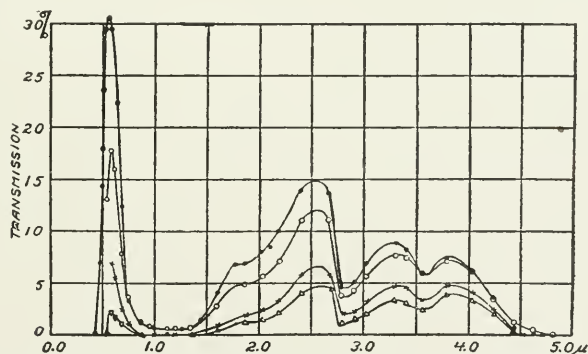


Fig. 58—Corning "New Noviweld" glasses: Top curve=shade 30 per cent; second curve from top=shade 3; next lower curve=shade $4\frac{1}{2}$; bottom curve=shades 6 and 7. Thickness of glasses, 2.2 mm. (Permission of Bureau of Standards.)

little more than white crown glass. Curve C gives the transmission of Crookes sage-green glass (marked Ferrous No. 30). The transmission in the green is about 45 per cent., while in the infra-red the maximum transmission is about 11 per cent. and this for only a narrow spectral region. Curve F is from a blue-green glass (marked

Lab. No. 59 from the American Optical Co.) which transmits about 43 per cent. in the visible. In the infra-red it is more opaque than the sage-green just described.

Pfund gold-plated glass. Metals are extremely opaque to infra-red radiations. In the visible spectrum gold has a region of low reflectivity and great transparency in the region of 0.5μ (green). This property naturally suggests itself as an excellent method of eliminating all the infra-red by covering white spectacle glass with a thin layer of gold. "The high reflecting power (metallie reflection of 60 to 80 per cent. as compared with the vitreous reflection of about 4 per cent. from glass) makes it desirable to mount these gold-plated glasses in a hood (goggles) which prevents reflection of light from the rear surface of the film into the eye. Curves A and C of Figure 57 show that the gold-plated glass is an extremely effective means of shielding the eye from the infra-red rays. At 1.5μ the transmission is only about 2 per cent., while beyond 2μ the transmission is less than 1 per cent. This Pfund glass obstructs 99 per cent. of the infra-red rays emitted by a furnace heated to 1050° C. The Pfund gold-plated glass, made by the American Optical Co., is put out as a gold film deposited upon Crookes A."

Blue-green glasses. Curve E of Figure 55 shows the transmission of a bluish-green glass (Corning G 124 JA) which has fifty per cent. transmission in the green and a very low transmission in the infra-red. This sample transmits only 6 per cent. of the infra-red radiation from a furnace at 1050° C.

Greenish-brown glasses. These glasses protect from the ultra-violet and to some extent from the infra-red rays. The maximum transmission in the visible is about 27 per cent. The coloring matter is effective in its absorption at 1μ but beyond 3μ the transmission is about as high as in uncolored glass.

Black glasses. Curve D in Figure 56 gives the transmission of a sample of Schott's black glass: the transmission in the visible spectrum is quite uniform and amounts to about 0.5 per cent. The sample used in Figure 56 transmitted little beyond 3μ although a lighter colored shade was transparent to 5μ . This sample transmits about 18 per cent. of the infra-red radiation emitted by a black body heated at 1050° C.

Noviweld glasses. As illustrated in Figure 58, the infra-red transmission of modern noviweld glasses is practically suppressed. The darkest shades transmit only about 1 per cent. of the infra-red radiation emitted from a furnace heated to about 1000° C. The trans-

mission in a rather selective region with a maximum at about 0.5μ (yellowish-green region) is rather marked.

The transmission curves in the visible and infra-red regions for the French Fieuzal and the German Hallauer glasses are shown in Figure 59.

It will be noted that glasses which absorb highly in the infra-red have either a low transmission throughout the visible spectrum or have the transmission band shifted into the green or blue.

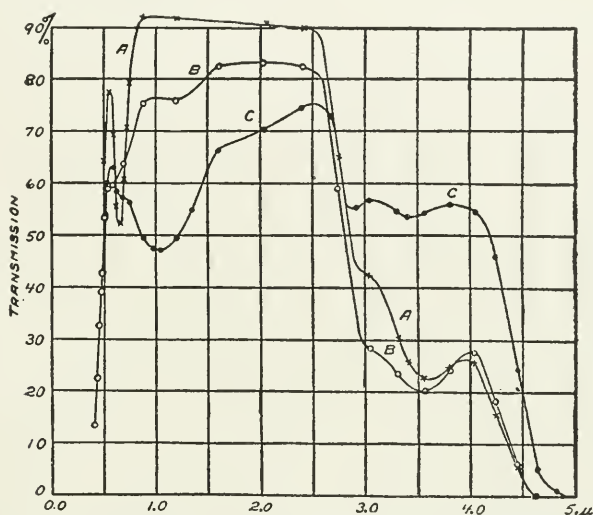


Fig. 59—A, Lab. No. 61, A. O. C. ($t=2.09$ mm); B, Fieuzal glass, shade B ($t=2.04$ mm); C, Hallauer glass ($t=1.41$ mm). (Permission Bureau of Standards.)

Coblentz and Emerson say, by way of conclusion, that “For shielding the eye from infra-red rays deep-black, yellowish-green, sage-green, gold-plated and bluish-green glasses are the most serviceable. For working near furnaces of molten iron or glass, if considerable light is needed a light bluish-green or sage-green glass is efficient in abstracting the infra-red rays. For working molten quartz, operating oxy-acetylene or electric welding apparatus, search-lights, or other intense sources of light, it is important to wear the darkest glasses one can use, whether black, green (including gold-plated glasses) or yellowish-green, in order to obstruct not only the infra-red but also the visible and the ultra-violet rays.”

Figure 60 gives a good comparative set of curves for the transmission of the eye media, yellow glass, sage-green, neutral tint, gold-

plate, greenish-brown, black and blue-green glasses and the emission curves of a black body at 1050°C .

A detailed examination of the infra-red transmission of a considerable number of glasses on the market and used for spectacle lenses was made in 1917 by A. W. Smith and C. Sheard. The results of their investigations are published in the *Journal of the Optical Society of America*. (Vol. II-III, Jan. 1919). The Hilger infra-red

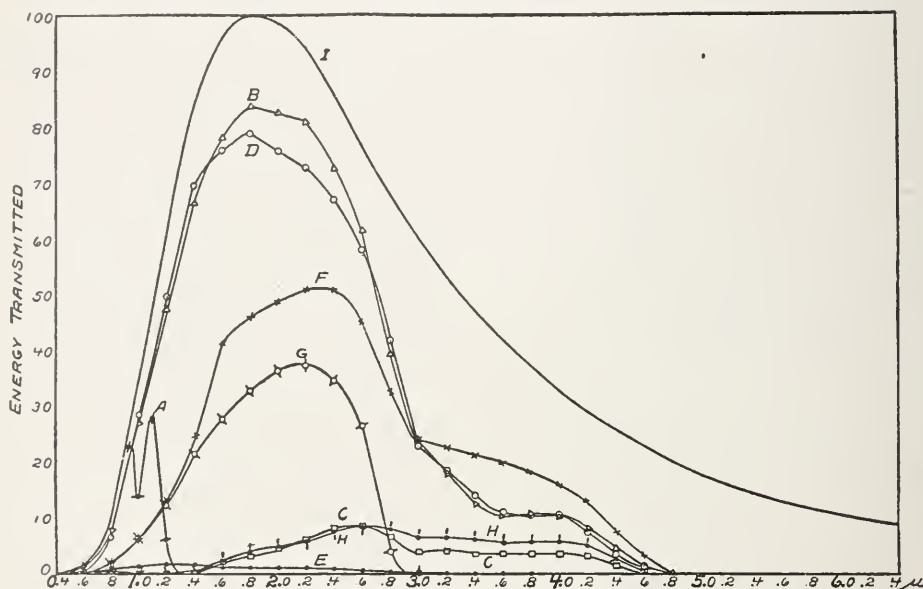


Fig. 60—A, eye media (Fig. 1, A); B, yellow glass (Fig. 1, B); C, sage green (Fig. 2, C); D, neutral tint (Fig. 2, B); E, gold plate (Fig. 3, A); F, greenish-brown (Fig. 4, A); G, black glass (Fig. 2, D); H, blue-green (Fig. 1, E); I, black body (1050°C). (After Coblentz and Emerson. Permission of Bureau of Standards.)

spectrometer was used for these investigations. The width of slits used in these experiments was such as to give a range of spectrum at the thermopile of between 0.1 and $0.26\ \mu$. A Nernst glower served as a radiation source. Two shutters were mounted in front of the spectrometer slit; one of these carried the specimen of glass to be studied, the other entirely screened the slit from the radiation of the glower. To get a measure of the energy transmitted by a piece of glass for a particular wavelength, the deflection of the galvanometer when no absorbing medium was interposed between the Nernst glower and the spectrometer slit was divided into the corresponding deflection of the galvanometer when the radiation passed through the glass plate

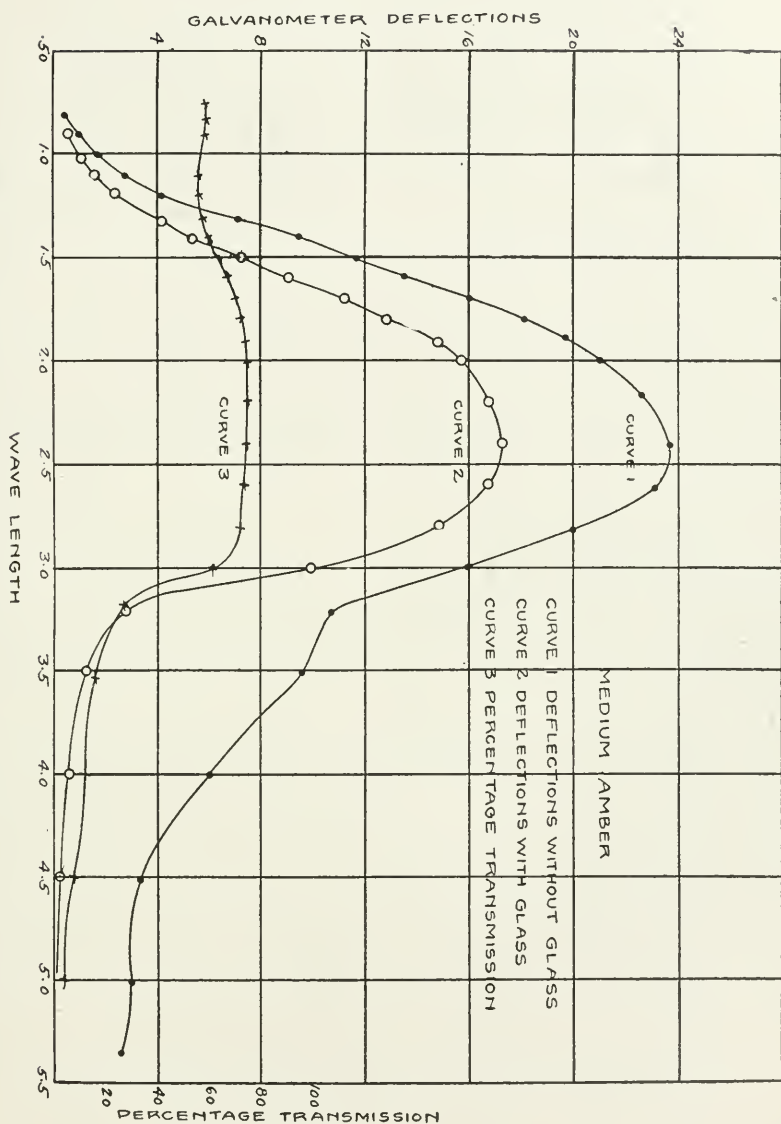


Fig. 61.—Curves of energy distribution from the Nernst glower and the transmission through a sample of glass.

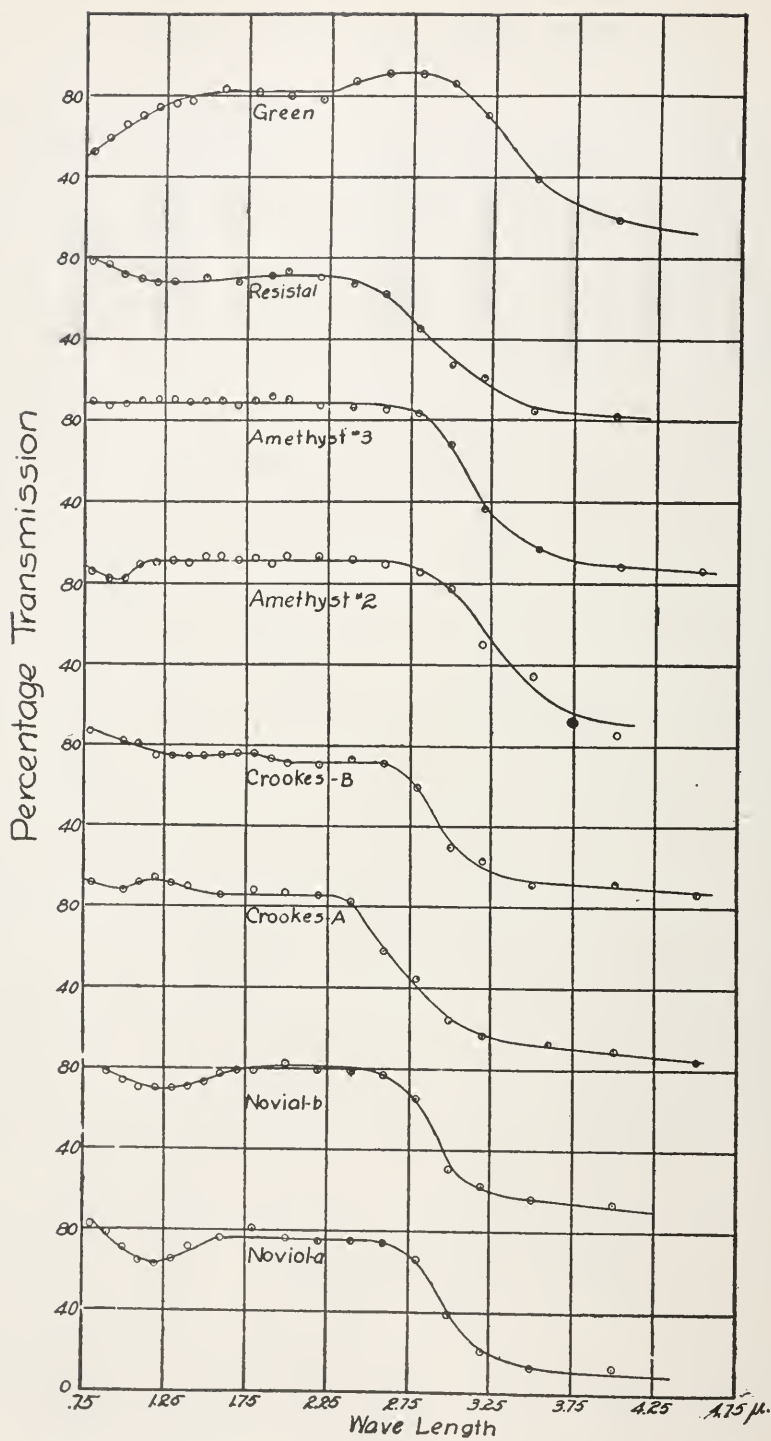


Fig. 62—Transmission of various ophthalmic glasses in the infra-red. (After Smith and Sheard; Courtesy of the *Journal of the Optical Society of America*.)

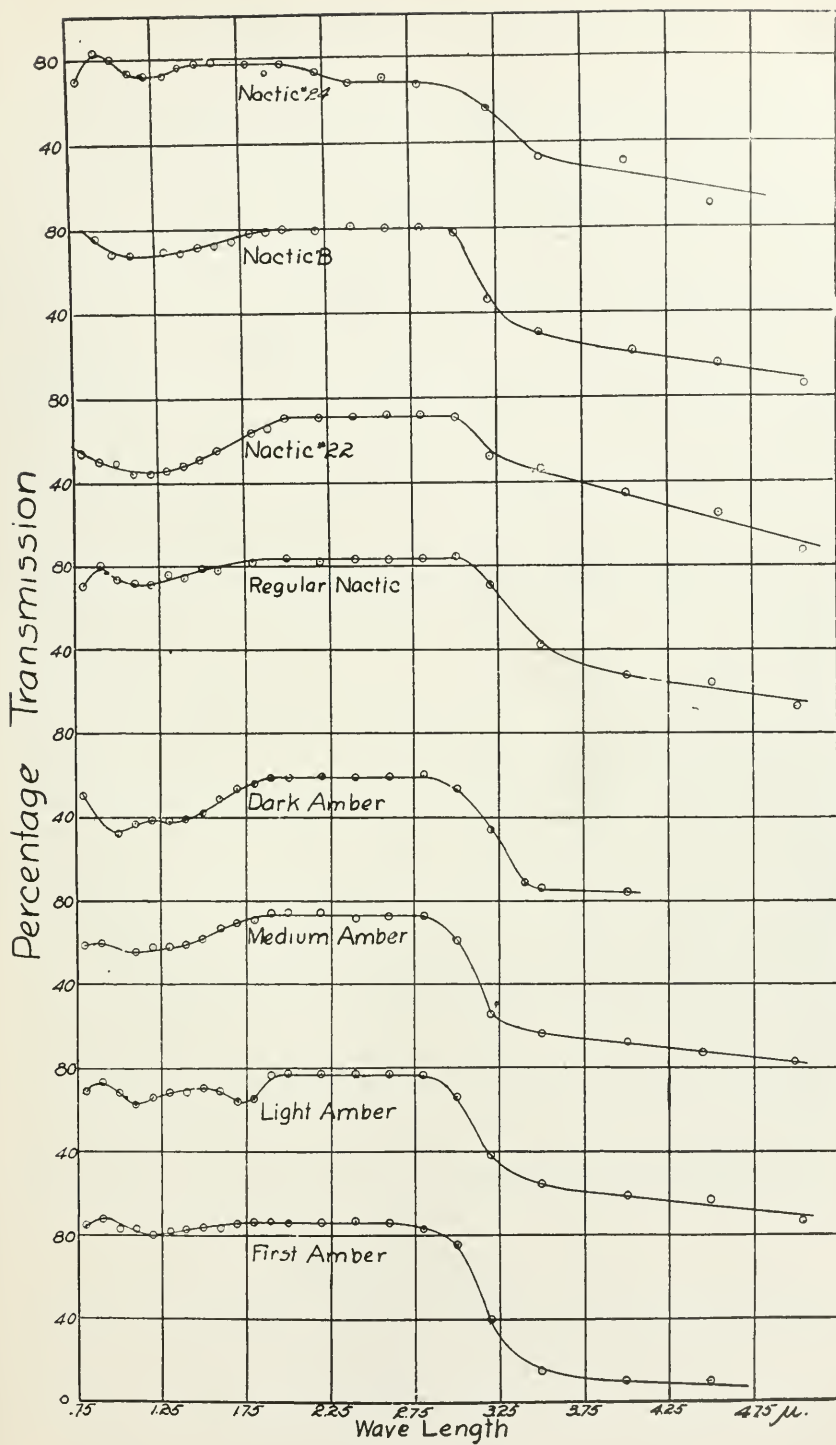


Fig. 63—Transmission of various ophthalmic glasses in the infra-red. (After Smith and Sheard; Courtesy of the *Journal of the Optical Society of America*.)

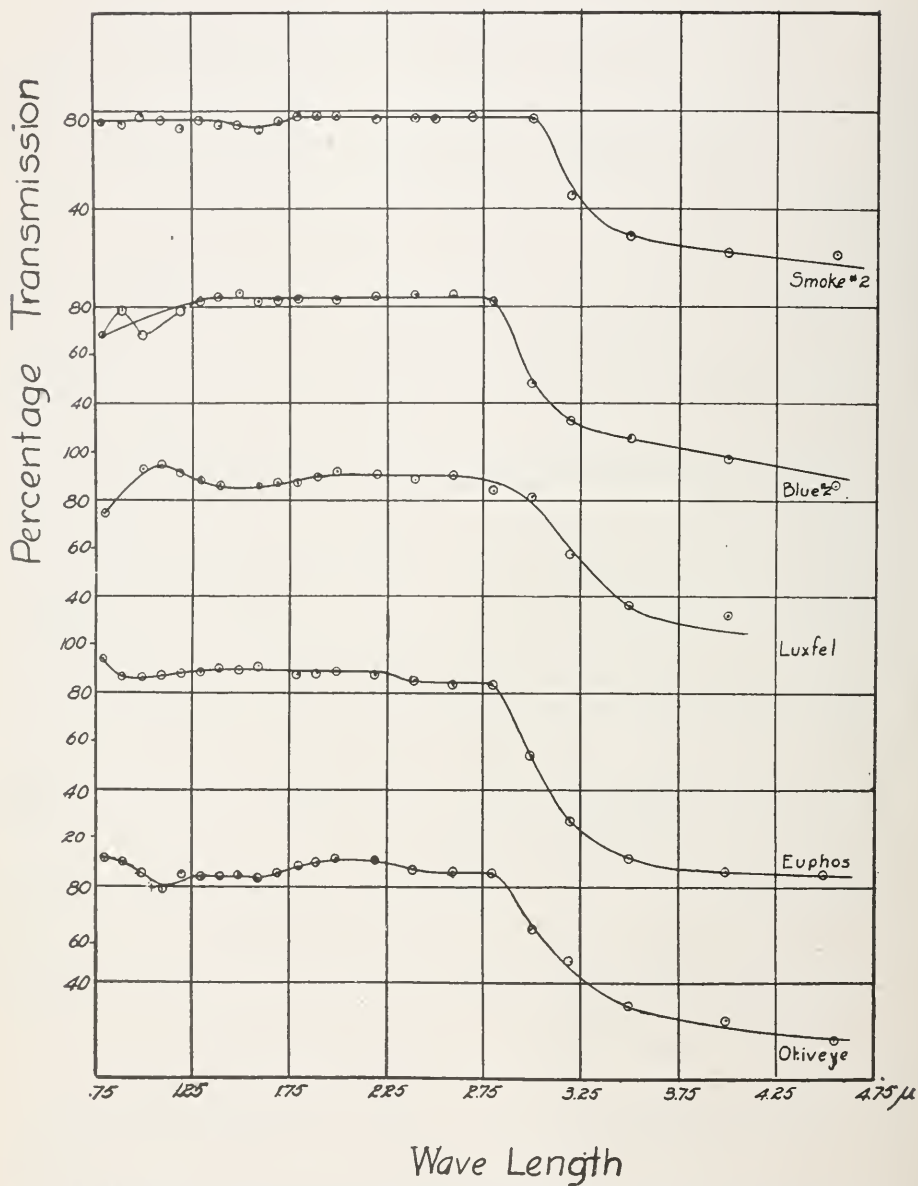


Fig. 64—Transmission of various ophthalmic glasses in the infra-red. (After Smith and Sheard: Courtesy of the *Journal of the Optical Society of America*.)

before it reached the spectrometer slit. Figure 61 gives a sample set of data obtained; the upper curve represents the energy distribution from the Nernst glower as measured by the galvanometer deflections and the lower curve, in a similar manner, measures the energy transmitted by the sample of glass. Figures 62, 63 and 64 contain a whole series of curves so related in general that various shades of the same colored glass are in sequence. The so called nacties—a trade name—and ambers occupy the whole of Figure 63. The rather noticeable selective absorption in the region of 0.75 to 1.75μ (broadly) exhibited by the yellow glasses (noviol, nactic and ambers) is evidently characteristic of such glasses. The heat transmission of the German Euphos glass is greater than for any of the common ambers as tested except possibly that marked "First Amber" which it closely resembles.

In Figures 62-64, the wavelengths are plotted on the horizontal axis; the percentages of transmission on the vertical axis. In order to economize space the vertical axis has been so lettered that the 80 per cent. of one curve coincides with the zero point of the curve lying immediately above it.

It seems useless to attempt to present the transmission properties of all the numerous glasses which are obtainable under different trade names but which have a characteristic color. The color of the same kind of glass may differ somewhat for different melts and for different parts of the same melt. This may have a marked effect upon the visible spectrum but does not in general affect the coloring matter. Certain colors of glasses are difficult to match. There is, in our opinion, too great a variety of colored lenses and a strict standardization of these is to be hoped for. At any rate, as Verhoeff and Bell write, "Perhaps the chief benefit of the agitation that has taken place within the last decade on the possible * * * dangers of the ultra-violet has been the bringing into prominence of the new types of protective glasses. These, intended primarily for the elimination of the ultra-violet rays, have tended to types of selective absorption which give advantageous results in modifying the visible light, which is really the chief object of concern of the ophthalmologist."

TRANSMISSION OF THE OCULAR MEDIA.

In 1908 Parsons of London, England, in conjunction with E. C. Baly, F. R. S., an authority on spectroscopy, and E. F. Henderson carried out some investigations on the absorption spectra of the cornea, lens and vitreous of the rabbit's eye. Later Parsons and Martin made a more extensive study, the results of which appeared in

the *Journal of the American Medical Association* (Vol. LX, page 2027, 1910). These researches were antedated in some particulars by those of Birch-Hirschfeld, Hallauer, and Schanz and Stockhausen. The accompanying diagrams (Figures 65-69) are from originals taken at the Imperial College of Science and Technology in the laboratories of Sir William Abney and Professor Fowler, F. R. S.

The Ultra-violet and the Visible.

In the research under discussion experiments were made to determine the precise limits within which the short wavelengths of light

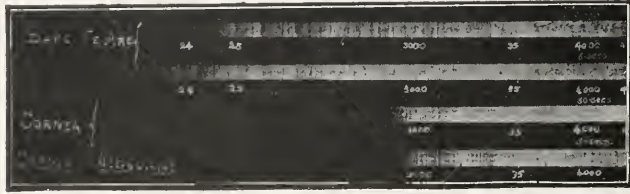


Fig. 65—The transmission of the cornea. (After Parsons.)



Fig. 66—Spectrograms showing the transmission of the crystalline lens. (After Parsons.)

were absorbed by the refractive media of the eye and the effects on these limits of keeping the media some hours after the death of the animal. The media were mounted in cells with parallel sides. In the case of the cornea and vitreous the cell was placed close to the slit of the spectroscopic. The lens was dealt with in two ways:— (1) Suspended in normal saline and placed at a distance from the slit greater than its focal length, so that a blurred image of the source of light was thrown on the slit. In this way horizontal lines were avoided on the resulting photographs and the possibility of stray light entering between the cell and the slit was prevented. (2) A thin layer of lens substance was squeezed out flat between the parallel sides

of the cell; this was done to eliminate any possible apparent absorption due to the shape of the lens.

All of the media were found to be uniformly permeable to rays between the wavelengths 6600-3900 t. m. For the ultra-violet rays the iron arc was the source and quartz was used throughout. Plates containing no dyes and giving no absorption bands were used. The results obtained by Parsons agree closely with those obtained by Schanz and Stockhausen and Birch-Hirschfeld. The shortest interval between the death of the animal and the taking of observations was three minutes. Observations were also made on the vitreous one hour, lens five hours and cornea several hours after the death of the animal.

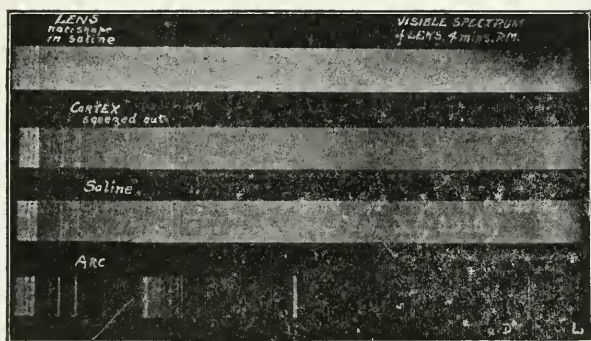


Fig. 67—Photograph showing the spectra of the crystalline lens in normal saline and the cortex. (After Parsons.)

The results obtained were identical with those from fresh specimens. The conclusions to be drawn from Figures 65-69 are:—

“*Cornea.* The cornea was found to offer no resistance to rays of wavelength longer than 2950 t. m., but all those beyond this limit were completely cut off.

Lens. (a) Suspended in normal saline. Rays of wavelengths less than 3500 t. m. are absorbed completely. The line is not a sharp one, the absorption commencing at about 4000 t. m. (b) Squeezed to different thicknesses. The absorption varies *pari passu* with the thickness of the layer of lens substance.

Vitreous. The vitreous in a layer $\frac{3}{16}$ inch thick shows a broad absorption band extending from 2800 to 2500 t. m., with a maximum at 2700 t. m. The margins of the band are ill-defined.”

It would be unsafe, however, to apply those results obtained with rabbits' eyes directly to the human eye without further investigations. The results of Schanz and Stockhausen (various papers in *Klin.*

Monatsbl. f. Augenh.) on the transmission of the cornea and the vitreous of a calf's eye are confirmatory. Birch-Hirschfeld also investigated the transmission properties of the media of the eyes of calves, pigs and oxen. He discovered that there was little difference in the absorption of the ultra-violet by these corneæ, giving the limit as 3060 t. m., somewhat higher than for the rabbit and considerably more than that of ordinary glass. Birch-Hirschfeld found the limit of absorption to be 3000 t. m. for a layer of vitreous 1 cm. thick. Greater differences which cannot be overlooked were found with various lenses. The limits of transmission of the rabbits' lenses varied between 3300 t. m. and 3900 t. m. For the pig's lens the average limit was 3300 t. m. with variations of about 150 t. m.; for the calf's



Fig. 68—Spectrograms showing the transmission of the ultraviolet by the vitreous. (After Parsons.)

lens at 3280 t. m. with variations of 120 t. m. and for the ox lens from 2700 to 4000 t. m. Schanz and Stockhausen examined the cornea and lens of a child who had glioma. The cornea absorbed up to about 3000 t. m. and the lens about the same. In a certain case of injury the corneal absorption was about the same but that of the lens was much greater, i. e., up to about 3500 t. m. Hallauer (*Klin. Monatsbl. f. Augenh.* 1909) found that the corneal and vitreous absorptions in the eye of a man extended to 2950 t. m. He examined the lenses from a considerable number of individuals of different ages and reached some valuable conclusions. He found the limits of absorption, on the whole, dependent upon age with some individual variations due to thickness, color and consistency. General conditions of disease also introduce a disturbing factor which must be taken into account in Schanz and Stockhausen's case of glioma. In babies and young children the absorption extends to about 4000 t. m. With this absorption, however, is combined an inability to absorb rays from 3000 to 3100 t. m. This transparent band is said to persist up to about the twentieth year and may be more extensive in certain debilitated con-

ditions. Rather peculiarly, with the loss of this band after twenty, it is claimed that the limit of absorption drops from 4000 t. m. to about 3770 t. m. With advancing age, however, the crystalline lens becomes more and more 'yellow' as a general rule and therefore its absorptive powers reach down into the violet, extending even up to 4200 t. m. Extreme debility from disease diminishes absorption to a minimum of 3750 t. m.

All of these investigations show that the lens has a powerful capacity for absorbing ultra-violet light in the region roughly comprised between 3000 to 3800 t. m. The fact is very easily and strikingly demonstrated by the strong fluorescence which occurs when these rays strike it. Schanz and Stockhausen attribute this fluorescence to

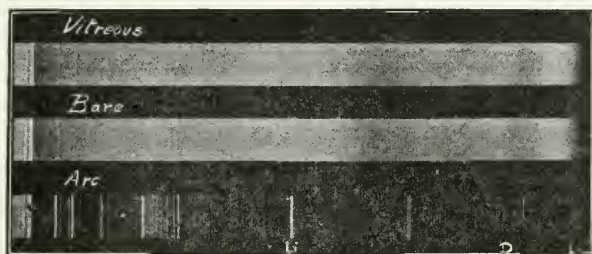


Fig. 69—Transmission of the ultraviolet by the vitreous. (After Parsons.)

the rays between 4000 t. m. and 3500 t. m. In the paper (*Illuminating Engineer*, 1910) on Glare—Its Causes and Effects, by Stockhausen, we find this statement:—"Now the ultra-violet rays between 3750 t. m. and 3200 t. m. are strongly absorbed by the eye-lens and those between 4000 t. m. and 3750 t. m. are for the most part altered into fluorescence light in the lens. Violet rays also, as Schanz and Stockhausen have shown, generally contribute to some extent to this change. Now, in general, it is only those rays which are absorbed by any substance which exert a chemical action upon it and we are, therefore, justified in supposing that it is the ultra-violet rays which are absorbed by the lens that produce the effect referred to above. In addition, the conversion of all ultra-violet rays and a portion of violet light into visible light by fluorescence indicates a transformation of energy and in the course of years may produce the injury to the eye known as cataract." But, as pointed out by Helmholtz, a fluorescent body always strongly absorbs those rays which induce the fluorescence. Hence the chief rôle must be allotted to rays between 3500 t. m. and 3000 t. m., for those from 4000 t. m. to 3500 t. m. are absorbed

to some extent by the lens. Also, as pointed out by Helmholtz and Stokes, the light causing a fluorescence is of a shorter wavelength than that of the emitted fluorescence. The investigation of this fluorescence of lenses is not unattended with complicating features, especially those due to fluorescence of the observer's own lenses.

The Infra-red.

The general absorption of the eye media has been studied by Aschkinass (*Ann. der Phys. und Chem.*, Vol. 55, 1895) in connection with his determination of the absorption spectrum of fluid water. He found that the transmission of the media of the eye for radiant energy in general was closely similar to that of water in a layer of equal thickness. The large proportion of water in these media would, of course, suggest a similarity and Aschkinass found the characteristic absorption bands of water in the experiments on the eyes of cattle and some control experiments on the human eye. The only notable discrepancy was in finding a considerably higher absorption in the cornea than would be warranted by its water equivalent. This Aschkinass ascribes chiefly to a film forming very rapidly over the surface of the dead cornea.

Hartridge and Hill, working in the Physiological Laboratory of Cambridge, England, have carried out some important investigations upon the transmission of infra-red rays by the media of the eye. This work is published in the *Proc. of the Royal Society of London*, Series B, Vol. 89, 1917. These investigators used a constant deviation Hilger spectrometer: in place of the eye-piece in the telescope there was inserted an adjustable vertical slit behind which was mounted a delicate thermopile of ten bismuth-silver elements. This thermopile was connected to a Paschen or Broca galvanometer and the energy falling upon the thermopile was measured by its deflection. The whole telescope was protected from radiant and convected heat by a silvered vacuum flask, the mouth of which was plugged with cotton. The light source was a single vertical Nernst filament. The spectral examination of the aqueous and vitreous offered no great difficulty mechanically, since they could be held in parallel-faced glass or quartz containers. With the lens and cornea this is not the case. Two methods are available: first, to dry the lenses superficially and then to squeeze them into a small trough. This method is not highly successful since the differences in refractive indices of various zones of the eye lens cause a series of confused images of the light source. A

second and better method is the immersion of the uninjured lens in some fluid of suitable refractive index that will neutralize the convergence exerted by the lens on a parallel beam of light passing through it. Hartridge and Hill found that carbon tetrachloride was most suitable for this purpose; it has no absorption bands over the region to be investigated, it does not precipitate the proteids of the lens and has marked antiseptic properties. An extensive series of experiments proved that lens preparations made in this way gave the absorption bands corresponding to those of water. The absorption curve of water in comparison with the lens of the eye is shown in Figure 70. It will be apparent to the reader that a superposition of two curves showing the amounts of energy of different wave-lengths transmitted could not occur unless "equivalent" thicknesses of water and media were taken. The following table gives such data:

TABLE III.

Structure	Thickness.	Index.	Water (per cent.).	Equivalent thickness of water.
Cornea	1.15 mm.	1.377	90	1.04 mm.
Aqueous	2.5	1.355	99	2.38
Lens center .....	....	....	84	....
Lens cortex	4.05	1.39	92	3.35
Vitreous	15.00	1.340	96	14.4

Such information is of great value since it permits the substitution of the equivalent thickness of water in experimental work, thus removing the tedium and uncertainty in results due to a time factor necessarily involved in dealing with anatomical media.

The table as given by Luckiesh (*Electrical World*, Oct., 1913) differs somewhat from the figures as given by Hartridge and Hill. Luckiesh's data are as follows:

Media.	Equivalent cms. of water.
Cornea	0.06
Aqueous humor	0.34
Crystalline lens	0.42
Vitreous humor	1.46
Total eye	2.28

The very important question arises: In what amounts do the infra-red radiations of different wave-length gain access to the deeper structures of the eye? In other words, What is the energy density in the eye media? The answer to this question has been undertaken by Luckiesh (*Elec. World*, 1913) and by Hartridge and Hill (*Proc. Roy.*

Soc. of London, 1917). The intensity of radiation after traversing any depth, d , can be computed from the following equation:

$$I' = Ie^{-ad}$$

where I and I' are the original and final intensities respectively, e is

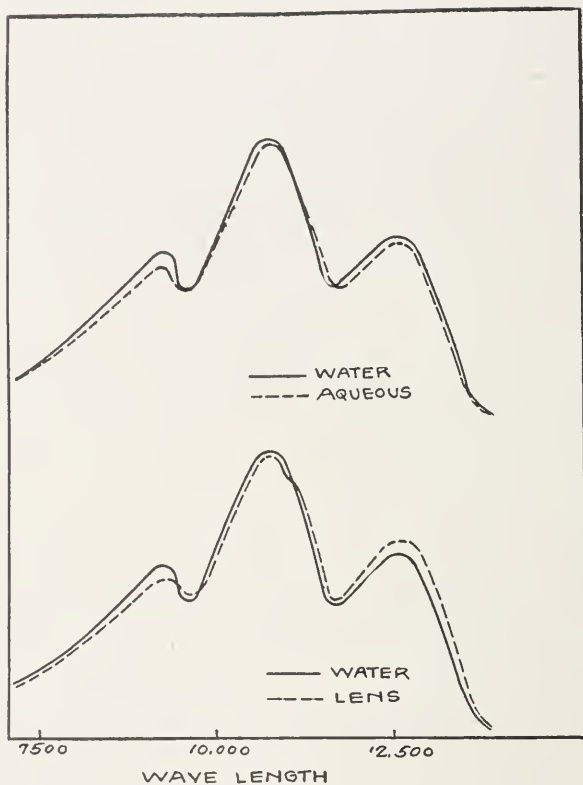


Fig. 70—A comparison of the absorption curves of water and the crystalline lens and the aqueous humour in the infra-red region. (After Hartridge and Hill.)

the base of the Naperian logarithms and a is the extinction coefficient. This can be further simplified for purposes of calculation thus:

$$I' / I = T = e^{-ad}$$

where T is the transmission coefficient. If I be taken as unity, then the value of I' is equal to that of the transmission coefficient. Aschkinass gives in his paper a table of extinction coefficients for pure water from 0.45μ to 8.49μ . Hence it is possible to compute the

transmissions of the various eye media within this range. Aschkinass did this for the whole eye: the transmissions of various layers of water corresponding to the eye media according to Luckiesh (*Elect. World*, 1913) are given in the curves of Figure 71. The first curve, that of the equivalent cornea, indicates the percentage of heat energy transmitted by the cornea of that incident upon the cornea; the second curve shows the percentage of heat energy reaching the anterior sur-

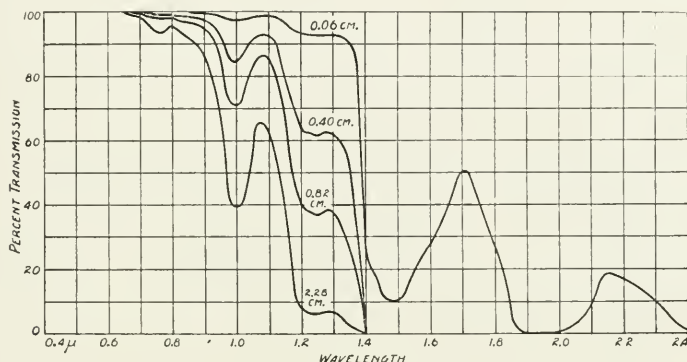


Fig. 71—Transmission of various layers of water corresponding to the eye media. (Courtesy of M. Luckiesh.)

face of the lens of that incident on the cornea, and so forth. Table IV gives the set of experimental data obtained by Hartridge and Hill (*Proc. Roy. Soc.* 1917) :

TABLE IV.

Wavelength.	Equivalent cornea.	Equivalent cornea and aqueous.	Equivalent cornea, aqueous and lens.	Equivalent eye.
7000	97.5	95	95	94.3
7500	97.5	95	94.6	91.3
8000	97.5	94.5	93.6	89.6
8500	97.5	94.2	93	89
9000	97.2	93.6	91.9	86.1
9500	94.4	85.4	76.2	48
9750	93.6	83.1	72.5	41.2
10000	94.5	85.8	77.2	50.3
10500	96.6	93	89	77.6
11000	95.9	90	85.1	67.7
11500	89.4	71.5	53.2	15.9
12000	86.4	63.7	42.2	7.9
12500	87	65.7	44.9	9.5
12750	87.3	65.6	44.8	10.6
13000	85.4	61	37.7	6.55

TRANSMISSION OF RADIANT ENERGY

Wavelength.	Equivalent cornea.	Equivalent cornea and aqueous.	Equivalent cornea, aqueous and lens.	Equivalent eye.
13500	75	36.4	13.4	0.24
14000	23.5	0.7	....
14500	5.5	....	....
15000	12.9	1.2	....
15500	28	1.38	....
16000	48.2	8.7	00.73	
16500	53.3	12.2	1.44	
17000	51.4	10	0.95	
17500	43.5	5.6	0.3	
18000	20.3	0.4		
18500	4.9			
19000	2.0			
20000	4.4			
21000	7.6			
22000	5			

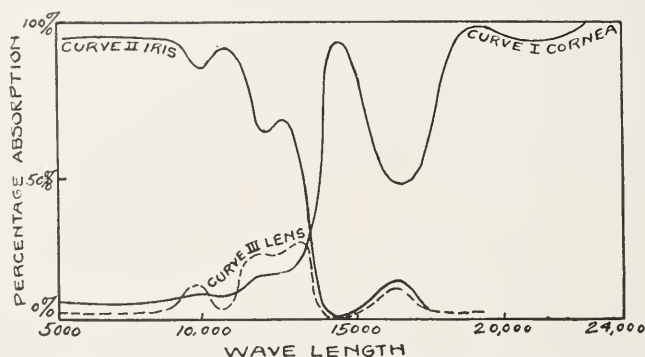


Fig. 72—Curves showing the percentages of infra-red radiation absorbed by the media specified of the amount of energy incident upon the medium named. (After Hartridge and Hill.)

These tables and curves show that there is practically no transmission of energy of wave-length greater than 23000 Angstroms. Paschen (*Wied. Annalen*, Vol. 52, 1894) showed that a layer of water 0.03 mm. thick transmitted at no wave-length more than twenty per cent. of the incident energy; a layer 2 mm. thick would, therefore, be totally opaque for wave-lengths greater than 23000 t. m. Furthermore, an inspection of Figure 71 shows that heat radiations of wave-lengths from 7000 to 9500 t. m. roughly pass into the eye almost unchecked and that a great deal of it reaches the retina. Figure 72 shows: Curve I, percentage of heat energy absorbed by the cornea of that incident upon it; Curve II, percentage of heat energy absorbed by the iris of that incident on the cornea and Curve III gives the percentage of heat energy absorbed by the lens of that incident on the cornea. The curves of this diagram are all representative of *absorption*; those in

Figure 71 give *transmission*. It will be noted that the absorption of the iris for wave-lengths ranging from 5000 to 10000 t. m. approximates 95 per cent. Hartridge and Hill (*l. c.*) say that the iris of the ox totally obstructs heat radiation of every wave-length which falls upon it. The lens, on the other hand, absorbs of the radiation which falls upon it by way of the aperture of the iris only about twelve per cent. Roughly stated, it can be said that four times the amount of energy is absorbed per unit area of the iris as is absorbed by the lens.

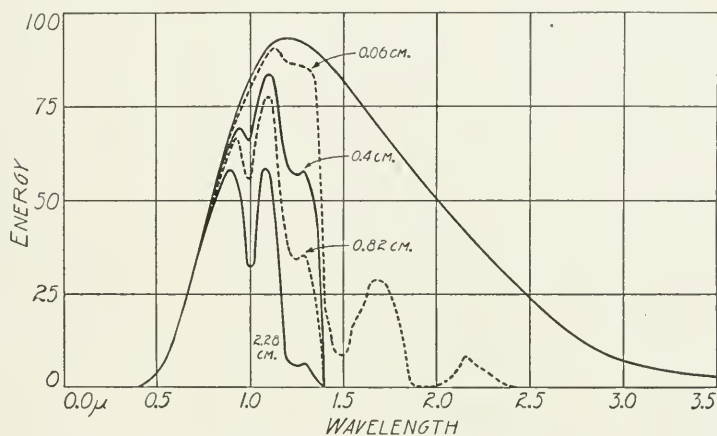


Fig. 73—Transmission of radiant energy from a 1.25 watt-per-candle tungsten lamp through various layers of water. (Courtesy of M. Luekiesh.)

Another point of interest is to apply these transmission curves to the curves representing the spectral energy distribution of black bodies at various temperatures and also to those of various illuminants. Figure 73 gives the transmission of radiant energy from a 1.25 watt-per-candle-tungsten lamp through various layers of water. (Luekiesh, *Elect. World*, 1913.) The numbers on the curves represent the thickness of water. For example, the percentage of total energy radiated from the carbon lamp and which is transmitted by the cornea is found by obtaining the ratio of the area under this curve (0.06 cm.) to the total area under the radiation curve. The difference between this and unity gives the absorption of the cornea. These percentages are found in Table V and plotted in Figures 74-76. Figure 74 gives the percentages of total black-body energy absorbed by the various eye media. It will be seen that for the cornea these percentages rapidly decrease with increase of temperature of the source, but much less rapidly for the aqueous, while the percentages of absorbed energy are at a maxi-

num for the lens and vitreous humor at about 3500° K. Most of the energy is absorbed in the outer portion of the eye.

TABLE V.

Percentage of energy absorption.

Percentage of total energy absorbed in

Source	Water of depth				Cornea	Aqueous humor	Lens	Vitreous humor
	0.06 cm.	0.04 cm.	0.82 cm.	2.28 cm.				
Black body 2000°K.	68.8	80.6	83.8	89.7	68.8	11.8	3.2	5.9
Black body 2500°K.	51.7	63.6	68.3	76.7	51.7	11.6	5.0	8.4
Black body 3000°K.	38.5	49.8	55.7	65.1	38.5	11.3	5.9	9.4
Black body 4000°K.	22.8	31.7	37.2	45.9	22.8	8.9	5.5	8.7
Black body 5000°K.	13.0	19.6	23.4	30.4	13.0	6.7	3.8	7.0
4 w.p.c. carbon.....	64.1	77.3	81.0	87.9	64.1	13.2	3.7	6.9
1.25 w.p.c. tungsten.	50.4	64.5	70.5	80.0	50.4	14.1	6.0	9.5

Percentages of energy absorbed have only been considered. The data can be reduced to that of finding the actual watts absorbed per lumen. In Figure 76 are plotted the values of watts per lumen for the black bodies at various temperatures. Multiplying these values

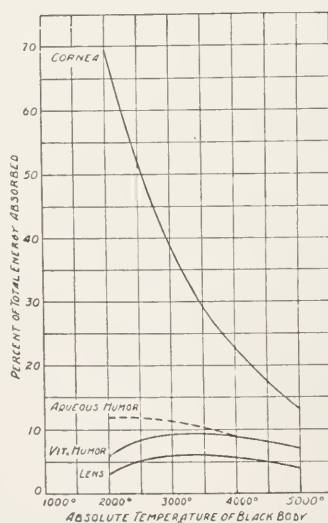


Fig. 74—Percentage of total radiant energy absorbed in various eye media. (Courtesy of M. Luckiesh.)

by the corresponding values for the curves of Figure 74, the actual watts absorbed per lumen are obtainable. Figure 75 carries these results. Curve *a* represents the absorption for the total eye; curve *b*

that of the cornea, and so on. These curves give the actual power absorbed in the eye media per lumen of light flux in the entering beam. All of the data show that the outer layer of the cornea absorbs a large portion of the energy which is not active in producing the sensation of

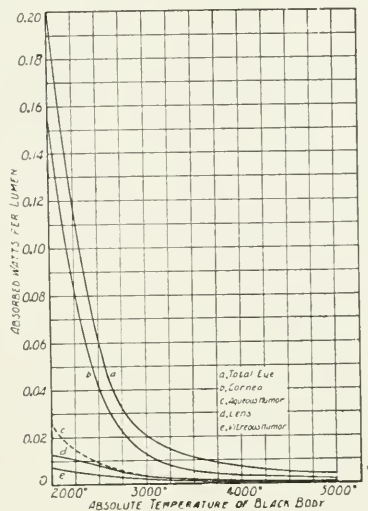


Fig. 75—Watts absorbed in the eye media per lumen in usual percentage of light. (Courtesy of M. Luckiesh.)

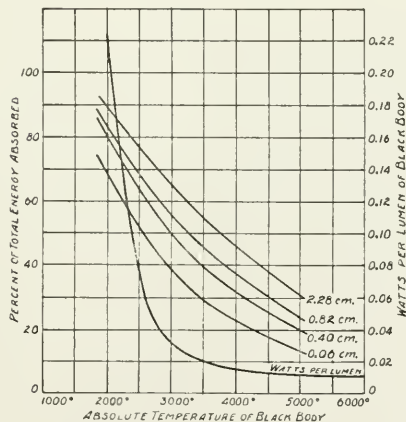


Fig. 76—Percentage of total radiated energy absorbed in the various layers of water. (Courtesy of M. Luckiesh.)

light. Also, as is to be expected, the absorbed energy per lumen of light flux incident upon the retina rapidly decreases with an increase of temperature of the source. It will be noted that about thirty times as much energy is absorbed in the total eye per lumen of tungsten light as per lumen of light from a black body at 5000° C. As Luckiesh

says: "This same ratio would hold approximately for sunlight if it were not for the moisture in the atmosphere which absorbs much of the infra-red rays before they reach the eye. This is perhaps fortunate considering the enormously greater intensities of illumination encountered in daylight." For instance, according to F. E. Fowle (*Astrophysical Jour.* 1913) the amount of perceptible water existing in the form of atmospheric water vapor averages about 0.7 cm.

The marked difference between the action of water and the eye toward the infra-red on the one hand and the ultra-violet on the other hand is noteworthy. The eye media transmit the visible and infra-red rays in the same manner as water. This is not true for ultra-violet radiation. Water is transparent to short-wave radiation far into the

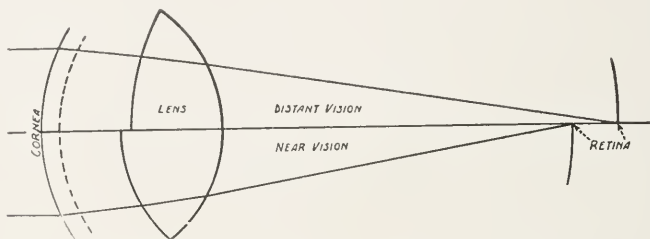


Fig. 77—Path of light in the eye. Small object. (Courtesy of M. Luckiesh.)

ultra-violet. In fact, no noticeable absorption has been found for any of the ultra-violet radiation from the mercury arc in a quartz tube.

The question of energy density in the eye media using sources subtending large and small solid angles has been discussed in a paper by Luckiesh (*Elect. World*, Sept. 1915). Figure 77 shows the path of light in the eye when a small object is looked at, while Figure 78 gives the path of light in the eye for an extended object. The useful beam of radiation included within a solid angle of 120° at the eye is shown by the full lines in Figure 78 when the eye is accommodated for reasonably near vision. If the object that is being viewed be illuminated with the same density of radiation of the same spectral character as that used for the small object tests at distance, it is obvious that the brightness of the retinal image will be the same and a much greater amount of energy will pass through the pupillary aperture. The energy density would thus be a million or more times as great as in the case of the more extended source. This is shown diagrammatically in Figure 79 for equal energy densities at the retina—that is, for equal

brightnesses of the retinal images. Curve *D* represents the condition for the extended source and curve *E* for the small source.

In this paper Luckiesh says by way of summary: "It is shown that when viewing luminous objects of small area (subtending a small solid angle) there is no serious concentration of energy in the eye media until the retina is approached. However, when viewing extended objects (large solid angle) there is a relatively much greater energy density in the lens and anterior parts of the eye than in the posterior portions. When the retinal images are of the same bright-

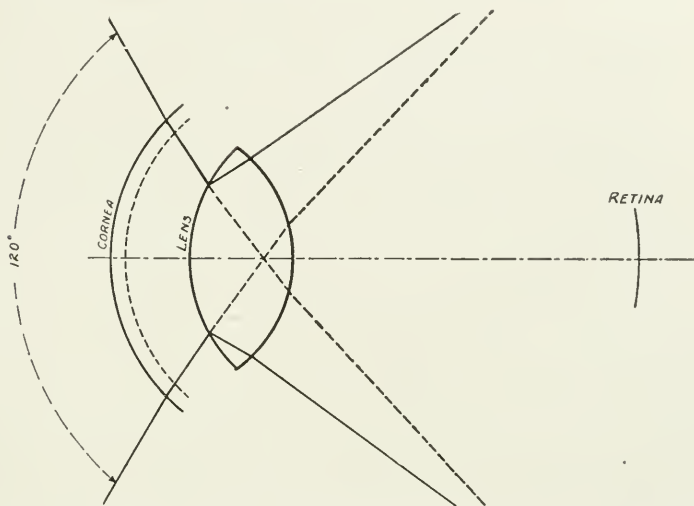


Fig. 78—Path of light in the eye. Extended object. (Courtesy of M. Luckiesh.)

ness, there will be a much greater energy density in the lens when viewing an object subtending a large solid angle than when the object subtends a small angle if the spectral character of the illuminant and the intensity of the illumination are the same. This indicates that large sources of a relatively low visual brightness might be effective in forming cataract or causing eye fatigue if the "absorption of energy theory" is correct. In fact, if the deterioration of the lens is due to ultra-violet rays, the latter might be present in such small amounts as to appear harmless, but when it is recalled that the energy density in the lens is very high when viewing extended objects, such as the sky, pavements, large surfaces of molten glass, metal, etc., it appears to be possible that the ultra-violet rays might be present in sufficient amount to do damage. From this standpoint sunlight, owing

to the greater intensities encountered, appears to be probably as effective in producing cataract and eye fatigue as ordinary artificial illuminants, even after allowing for the higher luminous efficiency of the former and the absorption of energy by the water vapor present in the atmosphere."

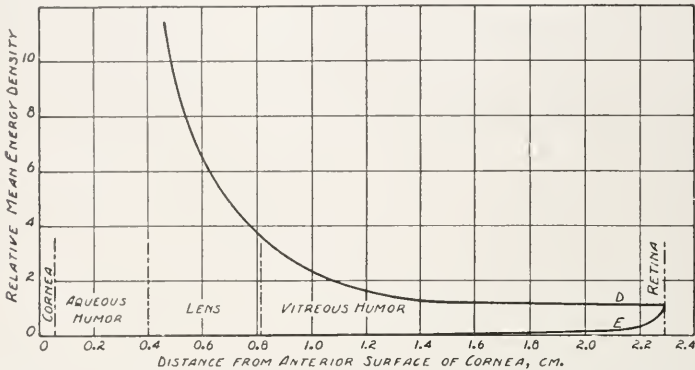


Fig. 79—Energy Density in the Useful Beams of Light from Sources Subtending Large (D) and Small (E) Solid Angles. (Courtesy of M. Luckiesh.)

—(C. S.)

Transparencies. Positive pictures on glass, intended to be viewed by transmitted light.

Transparent. That can be seen through; transmitting light so as to render objects visible that are beyond the transparent medium.

Transparent colors. Colors which transmit light.

Transparent media. Substances which transmit light without dispersion.

Transplantation of animal eyes. This subject has been discussed to some extent in the pages of this work. See, *e. g.*, **Comparative ophthalmology**, p. 2578, Vol. IV.

The *general biological aspect* of this subject is discussed by A. Fischel (*Am. Journ. of Ophthalm.*, p. 79, March, 1916) in connection with the experimental *transplantation of the lens and globe*. He notes that the larvæ of *salamandra maculata*, living in water and about 30 mm. long when the transplantation was performed, possess in the main a perfectly differentiated eye with a large, well-formed lens. If this lens is removed from the eye and transplanted into the connective tissue in any part of the body, the lens is well preserved at its new site for a long time, but finally undergoes a peculiar retrogressive transformation.

First, the transplanted lens changes its general shape according to the space at its disposal. This rapid change of shape proves that the

lens possesses a high degree of plasticity. It does not heal into the connective tissue, yet it does not share the fate of other transplanted masses which do not heal into the tissue. It does not disintegrate, it is not permeated and destroyed by wandering cells but it undergoes a retrogressive transformation in that its fibrous material grows gradually less and less and finally disappears altogether. This reduction may be combined with a simultaneous degeneration of the fibres.

On the other hand, the epithelial cells of the lens at first retain their size and shape and undergo a retrogressive metamorphosis only in the final stages of the whole procedure.

The forms which during this process are assumed by the lens are very similar to those through which it passes during its normal development, only they develop now in a reverse sequence. The fully differential lens, first is changed into one with a small quantity of fibres, then after the fibres have disappeared into a purely epithelial vesicle which is like the lens vesicle of normal development. We can therefore compare this process to those which are usually designated as "retrogressive or reverse development." This term is, however, justified in a very narrow sense only. It is just this process of reverse development of the lens which is valuable in studying the question.

After a purely epithelial vesicle has been formed this, too, is reduced until finally the whole lens is absorbed and gone without leaving a trace. During these processes of reduction, however, there appears at certain stages a very lively cell increase in the epithelium of the lens. This may be so great that small accessory lens vesicles or cell masses are formed which grow into the interior of the lens.

Not only whole lenses, but parts of the lens fibre mass have a like fate. The process of their retrogressive development takes the longer the larger they are and the firmer their elements are held together.

These cells of these transplanted pieces do not join with the tissue of the site of the implantation, but remain sharply distinct from them. The lens, therefore, preserves very strongly its peculiarity in comparison with other tissue cells, even at the final stages of the retrogression when its cells are already near disintegration. The same is the case if a lens or parts of one are transplanted into the epithelium of the skin, although this is genetically a very near relative of the lens.

It appears from this that the cells of the lens by their internal and probably by their chemical peculiarities differ materially from other tissue cells, even from those of the epithelium of the skin which are of the same derivation, and behave like foreign elements.

While this transformation resulted always when the lens alone was transplanted, it did not take place when, with the lens, the inner parts of the eye, especially the retina, had been transplanted. From this it is seen that the lymph contained in the cutaneous connective tissue cannot serve as nutritive fluid for the isolated transplanted lens and that the normal nutritive fluid in the eye must contain special parts which, produced by internal secretion, reached the lens cells from the retina and perhaps, too, from the inner tissue cells of the eye. This material is absolutely necessary for the preservation of the lens. When, therefore, the lens alone is transplanted and thus withdrawn from the influence of these materials it retrogrades.

Aside from the changes in the lens there are, also, changes in the tissue cells at the site of the transplantation. We are especially interested in those of the cutaneous epithelium. This is transformed in such a manner that it loses its characteristic signs. The normally present one-cell glands, Leiden's cells, so-called, retrograde and thus the morphological as well as the physiological character of the epithelium is altered; other changes concern the arrangement and peculiarities of the remaining cells. The entire result may be summed up in the statement that the epithelium assumes an aspect very similar to that of the earlier stages in its development and which—in the completely developed organism—can be likened to that of the corneal epithelium. In any part of the body such a transformation can be produced. It may, furthermore, be brought about not only by the lens and lens portions, but also by an eye deprived of the lens, by pieces of the inner membranes of the eye, even by disintegrated parts of them and by the tissue juice. A close study of these conditions proves that the cause of this transformation of the epithelium is of a chemical nature and is represented by material which is formed by the cells of the lens and the inner membranes of the eye and acts on the epithelium as a formative stimulus.

Since this material is formed probably normally in the eye and acts on the cornea, the assumption is natural that it has something to do with the preservation of the normal cornea, or at least its epithelium.

In consequence the existence of the lens and of the cornea in the normal eye is dependent on material which originates by internal secretion within the eye itself.

From development of mechanical experiments made in the past few years it is shown that the lens and corneal epithelium—at least in certain animals and especially in those we are interested in—are not contained preformed in certain definite and limited localities of the ectoderm. At early stages of the development, on the contrary, the

whole ectoderm, or at least a large area of it, possesses the ability to produce lenticular or corneal epithelial cells. What area of the ectoderm is to produce these depends on the eye cup, and the lens. Wherever these place themselves against the ectoderm, then lens and corneal epithelial cells are differentiated.

It is still a question whether the influence of the contact or of a chemical effect acts more decisively on the ectoderm. The results of this study make it appear probable that in the embryo already eye and lens produce and give off material which take an important part in the development of the lens and cornea. The origin of these organs is therefore not, or at least not principally, dependent on contact influence but on chemical causes, since material is formed within the eye which acts as a formative stimulus on the ectoderm. Even embryonic organs are therefore capable of producing an internal secretion and this secretion may take an important part in the organ development.

The transformation of the cutaneous epithelium which in the eye is necessary for the preservation of the lens renders the peculiar retrograding processes in the transplanted lens which we have just described more clear. In consequence of the lack of the normal nutrient fluid of the lens, that is, through a trophic cause, the fibres disappear. Thus the lens must gradually assume forms which are similar to those of its development until it forms a purely epithelial vesicle. In consequence of the continually unfavorable trophic conditions this also retrogrades and is absorbed.

The transformation of the cutaneous epithelium which in a certain sense is a "reverse" development, is plainly dependent on the lack of normal conditions in the connective tissue or due to irritating action produced by the transplanted tissue.

Thus these two kinds of "reverse development" are in the main explained by trophical conditions, without the aid of a special tendency to reverse development. It is also plain that such processes of "reverse" development cannot without further study permit of those far-reaching conclusions which have been drawn from them by others in a general biological sense.

Transplantation of animals' eyes into human sockets. See **Enucleation of the Eyeball**, p. 4469, Vol. VI of this *Encyclopedía*.

Transplantation of cilia into the anterior chamber. In addition to the matter given on p. 2214, Vol. III of this *Encyclopedía*, H. L. Begle (*Mich. State Med. Soc. Jour.*, Nov., 1916) has noticed that cilia are transplanted into the anterior chamber of the eye most often in those types of perforating injuries where the penetrating instrument

does not remain in the eye. Occasionally a fragment of steel or copper may carry with it cilia into the vitreous or the metallic fragment may enter the vitreous while the cilia are left behind in the anterior chamber. The cilia may be free and movable in the anterior chamber; more often they are fixed either through contact with the iris, pupil or the angle of the chamber, or through being embedded in exudate, blood, or opaque lens matter. Often one end of a cilium remains fixed in the corneal wound.

The presence of cilia in the anterior chamber may be quite easily overlooked. Focal illumination and a monocular or binocular loupe are of assistance in their detection.

Inasmuch as cilia, because of their position and function, catch innumerable dust particles and dirt, it might be supposed that when carried into the anterior chamber, they would frequently be a source of infection and set up severe purulent or plastic inflammation. The contrary, however, appears to be true, cilia in the anterior chamber being tolerated by the eye generally for considerable periods without marked reaction or serious results. In explanation of this phenomenon attention may be called to the fact that the rapid filtration of aqueous from the anterior chamber allows little opportunity there for bacterial growth. Moreover, cultural attempts by Müller showed, rather surprisingly, that cilia are not very often harborers of pathogenic microorganisms. Even when infection does occur in perforating wounds where cilia have been implanted, the infection may have been brought about by the perforating object rather than by the cilia.

If the cilium be a carrier of pathogenic microorganisms it can undoubtedly set up purulent or plastic inflammation. Two cases reported by Hirschberg point with certainty to cilia as a source of such infections, for in both instances a circumscribed purulent inflammation cleared up after the removal of the implanted lashes.

While cilia, as stated, may remain in the eye for many years without giving rise to any disturbing symptoms, in many cases they have caused sooner or later complications, such as recurrent irritation, mild plastic inflammation, and epithelial tumors or cysts. Mechanically, cilia may give rise to irritation especially if a point is in contact with the iris or cornea. Partial expulsion of cilia from the anterior chamber has been reported. This appears to be largely due to the long continued irritant action of the cilia at the point of contact with the cornea. Iris hyperemia and mild plastic inflammation may occur at repeated intervals from the scratching and pricking to which the iris is subjected during normal movements of contraction and dilation. Exudate may be thrown around the eyelash at such

times. When plastic inflammation occurs in perforating wounds, where in addition to the presence of implanted cilia there is traumatic cataract, anterior synechia or wounds in the iris, the cilia may be only one of the responsible factors in the inflammation.

Transplantation of human tissues in eye surgery. OCULAR HOMOPLASTY. The *transplantation of ocular muscles and tendons* has been considered on p. 8239, Vol. XI (and elsewhere) in this *Encyclopedia*.

Transplantation of portions of vertical recti for abducens paralysis. The record of a case operated upon with a partly new technique is furnished by O'Connor (*Amer. Jour. Ophthalm.*, March, 1919). "E. C., female, age 8, came with the right eye squinting inward, approximately 35° arc. Mother is certain that this condition existed since the child's second year, possibly longer. There is no doubt that the case is one of complete paralysis of the right external rectus; and she was considered a suitable case for the transplantation operation. This was done under general anesthesia. The technique differed in two points from that employed by others in similar cases."

The externus and outer portions of the vertical recti were exposed through a long incision concentric with the cornea and about 1 cm. distant therefrom.

The outer third of each vertical rectus tendon was isolated with its superimposed capsule of Tenon, split far back, and shaved off the sclera. This the writer considers a very important point because in this way the fibrous attachment is included, and will hold a stitch from slipping out. If the cut is made back of this point, the stitch will slip out along the parallel tendon fibers, unless tied so tightly as to cut itself out by necrosis.

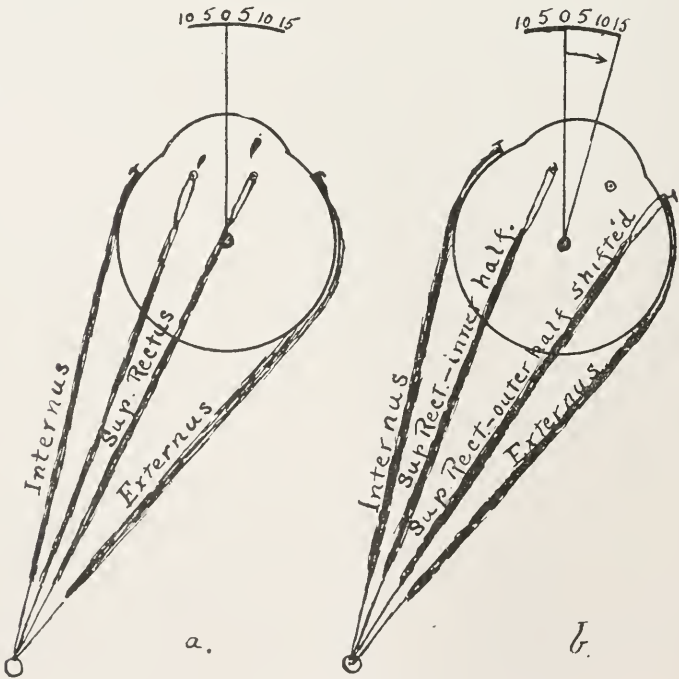
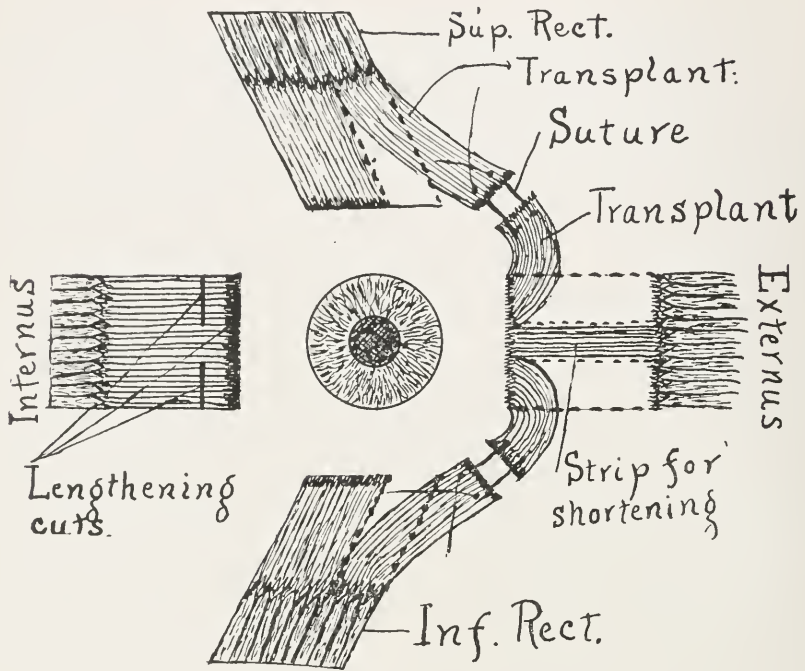
The externus tendon was next isolated freely, bared of its capsule, and divided lengthwise into three portions of equal width. The two lateral ones were then cut out free, well within the fibrous portion of their junction with the muscle tissue, for exactly the same reason that the vertical recti were shaved from the sclera.

The object of the procedures was to permit a good overlap with the vertical recti slips, without undue tension on the stitches.

The central tongue of the externus was then shortened by the author's "double-hitch" method.

The upper section of the externus was then united to the transplant from the superior rectus by a mattress suture inserted, as shown in the sketch. Then the lower section of the inferior rectus was similarly united to the transplant from the inferior rectus; the conjunctiva was then sutured.

Two weeks after the operation: Esophoria 1° in primary position.



Transplantation of Vertical Recti. (O'Connor.)

R. rotates outward 35° easily. No diplopia within limits of glasses. There was a perfect cosmetic result and, for all positions near the primary, practically a perfect functional result.

For *keratoplasty* or *transplantation of the cornea*, see p. 3492, Vol. V, and under **Conical cornea** of this *Encyclopedia*.

Homologous corneal transplant. Ancel Martin (*Amer. Jour. Ophthalm.*, August, 1918) reports a case of corneal transplantation in which the whole thickness of the cornea was replaced by the cornea from an eye about to be enucleated.

The operation was not successful from a visual standpoint, but it demonstrated the vitality of the eye structures, and presented some new points in operative technique which may be of assistance to others who are experimenting with corneal transplants.

N. W., a miner, lost his left eye from accident. Phthisis bulbi followed. Right eye: a marked fullness of the conjunctival vessels, moderate ciliary injection and tenderness; dense corneal leucoma. There remained a small area of cornea, about 2 mm. in width, near the upper sclerocorneal margin which was less dense, and through which an indistinct view of the iris was had. Fine vessels covered the entire corneal surface. Tension—1. Pupil undoubtedly occluded. Optical iridectomy was performed. The result was preception of hand movements, when the upper lid was elevated with the finger. This amount of vision being of no value, a corneal transplantation was performed, under the following technique.

By means of a hypodermic syringe the conjunctiva of the globe was ballooned with normal salt solution and divided at its sclerocorneal insertion. The pouch-like conjunctival sac could then easily be drawn together over the cornea. Three mattress sutures were placed but not tied. An instrument having the diameter of 8 mm. was used to trephine the cornea. The degenerated iris was found adherent to the lens capsule, the lens cortex having been absorbed. The capsule, together with the remains of the iris, was gently drawn forward and excised with scissors, which procedure exposed the vitreous.

Using the same trephine, a corneal transplant was removed from the eye of another patient, whose eye was soon to be enucleated because of the presence of stone within the globe; a negative Wassermann having been demonstrated. The transplant was transferred to the eye of the first patient, where it readily adapted itself to its new position. No corneal sutures were used. The conjunctival sutures were then tied, burying the transplant within the conjunctival sac.

On the seventh day the eye was dressed. The sutures had cut loose and the conjunctiva was retracted, exposing the new cornea. With

the nourishment furnished by the conjunctival flap, the transplant was alive and continued so, although it was found to be opaque. After two months, the corneal opacity was somewhat cleared, so that the patient was able to discern hand movements. Tension was normal.

Conjunctival transplantation is considered on p. 3508, Vol. V, and under **Blepharoplasty**.

Transplantation of portions of the lid tissues is discussed under **Automarginoplasty**, p. 709, Vol. I; and **Arlt-Jaesche operation**, p. 589, of the same volume.

Homologous transplantation of skin and mucous membrane in eye surgery has been described under **Blepharoplasty**; **Entropion**, and **Grafting**, p. 5628, Vol. VII; and also under **Skin graft** in this *Encyclopædia*.

Transplantation of ocular tendons. See p. 8237, Vol. XI, as well as under **Tendon transplantation** in this *Encyclopædia*.

Transplantation of pterygium. An operation, introduced by Desmarres. See p. 10451, Vol. XIV of this *Encyclopædia*.

Transplantation needle. A number of these small instruments have been devised from time to time. One of them is shown in the text.



Lance-Needle for Transplantation.

Transpositions of optical formulæ. See **Refraction and accommodation of the eye**.

Trans-scleral illumination. See **Transillumination**.

Transverse film. See **Band-shaped keratitis**.

Transversus orbitæ. An anomalous muscle arising from the os planum which passes across the orbit either above or below the levator palpebræ and is inserted into the outer margin of the orbit.

Trapa natans. WATER CHESTNUT. A species found in southern and middle Europe, middle Asia, and northern and central Africa. The upper, leafy portion of the stem has been used in poultices as a discutient and the expressed juice in eye diseases.

Trap-door operation. A name given by Priestley Smith to any operation for glaucoma in which a piece of the iris is opposed to or included in an opening through the sclera to prevent closure of the drainage wound.

Traubengeschwulst. (G.) Staphyloma.

Traumatic amblyopia. See **Amblyopia, Traumatic**.

Traumatic cataract. An opacity of the lens resulting from injury to the eye. See p. 1756, Vol. III of this *Encyclopædia*.

Traumatic excavation of the macula. See **Hole at the macula**; as well as **Retina, Injuries of the**.

Traumatic irideremia. See **Injuries of the eye**, p. 6303, Vol. IX of this *Encyclopedia*.

Traumatic macular disease. HAAB'S MACULAR DISEASE. See **Retina, Injuries of the**.

Traumatic neuroses. See **Hysteria**, p. 6129, Vol. IX; **Psychoses, Ocular**; **Psychotherapy**; and **Shellshock**.

Traumatic syndrome. See **Syndrome, Traumatic**.

Travers, Benjamin, Jr. A son of Benjamin Travers, Sr., and himself a surgeon and ophthalmologist, who, however, died very young. The date of his birth is not known. He was for a short time resident assistant surgeon at St. Thomas's Hospital, and died in 1868.—(T. H. S.)

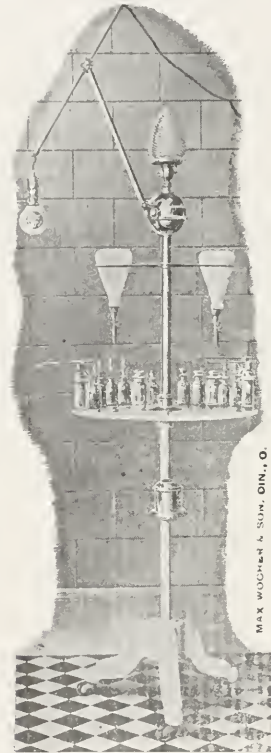
Travers, Benjamin. A distinguished London surgeon, and ophthalmologist, who published in 1820 the first extensive text-book on the eye to appear in the English language. Born at London in 1783, he became in 1800 a private (and the first) pupil of Sir Astley Cooper, who had just then been appointed surgeon to Guy's Hospital. In 1806 he became an M. R. C. S. Shortly afterward he was made anatomical prosector at Guy's Hospital, and, almost immediately thereupon, surgeon to the Volunteer Brigade of the East India Company. In 1810, however, he returned to civil practice, and was elected surgeon in that year to the Eye Infirmary, later known as Moorfields. In 1813 he became a Fellow of the Royal Society. After the reception of many other honors, he was made, in 1837, surgeon-extraordinary to the Queen, and in 1840 surgeon-in-ordinary to Prince Albert. He is said to have been a slow and tedious operator, but very careful and safe, and to have had remarkably good results.

Says Percy Dunn, in *The British Journal of Ophthalmology*, May, 1917: "Travers was married three times, and by these marriages had a numerous family. Only one son, his eldest, also called Benjamin, joined his father's profession—father and son established a record in the history of the college. Each was elected a Fellow of the College at the same time under the Honorary Rule, in 1843, when the new distinction was founded.

"In the following passage we gain a glimpse of Travers, as he appeared to his contemporaries: 'He was tall, large-framed and well-proportioned, with a highly intelligent and pleasing countenance. His manners were prepossessing, and in consultation with his professional brethren he showed a high-bred courtesy which marked the refinement of his mind. He was ever popular, whether in the profession

or out of it, and the announcement of his death will be received with heartfelt regret both at home and abroad.' ”

According to Stromeyer, writing at the time: “Travers was apparently older than A. [Astley Cooper], not so large and stately as he; but he had a very intellectual head and very gentle, amiable manners. He made his visits regularly to St. Thomas’s Hospital, and indeed still operated. He turned over all the more difficult operations



Sanders' Ophthalmological Treatment Stand.

to his colleagues, Green and Tyrrel. It was a pleasure to behold Travers in company with his son, a youth of remarkable beauty, who, under his father's guidance, became an important practitioner.”

Travers died on Mar. 6, 1858.

Aside from numerous works and articles on subjects connected with general surgery, Travers wrote:

1. Observations on cataract. (*Med. Chir. Trans.*, IV, 1813.)
2. Further Observations on cataract. (*Ib.*, V, 1814.)

3. On Iritis. (In "*Surgical Essays*," by Astley Cooper, F. R. S., and Benjamin Travers, F. R. S., London, 1818. To Travers is owing the use of mercury in non-specific iritis.)

4. *Synopsis of Diseases of the Eye and Their Treatment*. (The greatest English work on ophthalmology to and including its time. London, 1820; 2d ed., 1821; 3d ed., 1824; American ed., 1825; Italian trans., Pisa, 1823.)

5. Observations on the Local Disease termed Malignant. (Treats, among other matters, Pseudoglioma. *Med. Chir. Trans.*, XV, London, 1829.)

6. *Principles and Practice of Ophthalmic Surgery*. (Together with J. H. Green, London, 1839.)—(T. H. S.)

Treatment stand. This subject has been discussed under **Hospitals**, p. 6036, Vol IX, and under **Office equipment**, p. 8472, Vol. XI of this *Encyclopedia*. A very good sample of the numerous stands in market is Sanders'. See the figure. It consists of a white enameled base and standard, having a white glass table. On the edge of this table are a series of drop, tincture and salt mouth bottles, held in oxidized brass clips. It is also supplied with several clips for spray-holders. Above these, two boric acid flasks are suspended in nicked percolator rings. These flasks have pinch cocks on the bottom and are inverted so that the dust does not get into them. Over these flasks, on the top of the stand, is an electric fixture which is adjustable and is supplied with a 32 C. P. ophthalmic lamp. The entire outfit has an ordinary illuminating lamp.

Trefle. (F.) An instrument devised by P. F. B. Pamard (q. v.) for fixation of the eyeball in cataract extraction.

Trefoil keratectomy. See under **Keratectomy**, p. 6750, Vol. IX of this *Encyclopedia*.

Trembecki, Onuphrius. A Polish physician, who devoted considerable attention to ophthalmology. Born in Jaslo County, Galicia, in 1812, he received his medical degree in 1838 at Vienna. In 1841 he was appointed hospital physician at Sacz, and, at the same time, practised at the bathing resort, Szczawnica. In 1862 he was made a Fellow of the Cracow Academy of Sciences.

Aside from compositions in the Polish language, he wrote "*Allgemeine Anweisung zum Augenkrankenexamen, mit Diagnost. Tabellen*," etc. (Cracow, 1859-'68.)—(T. H. S.)

Tremor saturninus. (L.) Tremor due to lead poisoning.

Tremulous cataract. A cataract due to laceration or defect of the zonule of Zinn, so that movements of the eyeball cause trembling of the iris and of the cataract.

Tremulous iris. See **Iridodonesis**, p. 6606, Vol. IX of this *Encyclopedia*.
Trench neuritis. In addition to the definition given under **Neuritis**, **Trench**, p. 8330, Vol. XI, other information is added here regarding the *ocular symptoms of trench neuritis*.

Allen Greenwood (*Trans. Am. Ophthalm. Soc.*, vol. xiv, pt. ii, 1916) reports his experience with the Harvard surgical unit in the B. E. F., Base Hospital No. 22 in France, for three months. In the *earlier cases of trench nephritis* which were admitted an examination of the fundus was not made until after the practical disappearance of the general edema, and no changes were found. However, he examined the later cases of trench nephritis immediately on admission, and in his first six cases found *neuro-retinal edema in two, optic neuritis in two, slight edema of the disc in one, and normal fundus in one case*. After six and a half hours' rest in bed and profound slumber, the first five showed a marked decrease in the fundus changes. Eighteen hours after admission four of the six cases showed practically normal fundi, while the two optic neuritis cases showed only a very slight neuritis. After another 12 hours, there was no sign of any fundus disturbance in any of them.

Subsequent cases of trench nephritis showed similar changes, and in no case was there the slightest evidence of any degenerative processes.

Seventy or eighty soldiers suffering chiefly from trench nephritis and from the Macedonian front were examined by J. Kirk (*British Med. Journ.*, Jan 5, 1918). They were chiefly active cases between 20 and 30 years of age, and were examined by Kirk with reference to eye complications. Nearly all the cases presented the disease in a severely acute form, and almost invariably marked retinal congestion, with large pulsating veins were present. There were no signs then, however, of any patches of exudation or nerve involvement. Some weeks later, however, more definite changes of nerve swelling accompanied by patches of retinal exudation were seen. While the spots of exudation were generally in the usual situations, that is, near the disk, and in the macular area, in no case was seen the typical silvery, star-like figure of the chronic cases as figured in the text-books. Hemorrhage was not common. Those seen were of the small, punctate variety, and not of the striate or flame-like character. The optic disk was often affected, the changes varying from a definite swelling to slight wooliness and indistinct edges. Small areas of edema were noticed, especially along the course of the veins. An important point was that in several of the series Kirk was able to trace the gradual absorption of some of the smaller patches of exudation.

Kirk believes that the pathology of this condition is probably an acute congestion resulting from some specific toxin, that the exudation which ensues is partly lymphoid and partly cellular in nature, and that this deposit probably clears up in the great majority of cases, without leaving any permanent results. The condition is one which is probably allied to the acute retinitis of pregnancy, scarlatina, and acute uremia, and should not be confounded with the retinitis of chorionic kidney inflammation with its permanent changes in the retinal circulation vessels and tissues.

Binocular retinal separation in nephritis is a comparatively rare condition and seldom, if ever, in civil life, does the disease terminate in the recovery of the patient. Furthermore, this condition has been seldom seen in so-called trench nephritis.

Lt. Col. G. S. Derby (*Amer. Jour. Ophthalm.*, March, 1919) describes such a case in a soldier, aged 19. The eye grounds at first showed obscuring of the disc margins; otherwise nothing. About this time his sight began to get poorer but subsequently began to improve. At the beginning of his illness he had a marked edema of the conjunctiva which later disappeared.

A later examination, right and left, showed a marked neuroretinitis with some swelling of the disc and hemorrhages and areas of pigmentation throughout the fundus, together with whitish areas of degeneration. Changes were more marked in the left eye. In both the right and left eyes was found marked separation of the retina downward, reaching almost up to the macula region and the disc. Vitreous opacities were present in both eyes.

At this time the patient was markedly improved in general condition and he stated that his eyesight was considerably better. V. R.=6/18, V. L.=6/26. The fields showed contraction as indicated on the chart. At the time the patient was seen he was considered to be convalescent. His urine practically cleared up.

Trepan. See **Trephine.**

Trepanatio. (L.) Trepanation or trephining.

Trepanation. TREPHINING. TREPHINATION. A number of writers, including Caspar Pischel, have pointed out that Webster's dictionary differentiates a *trephine* from a *trepan* in that the former is the latter with a center pin. It seems probable, therefore, that in speaking of the Fergus-Elliot operation for glaucoma (q. v.) and the von Hippel corneal transplantation (q. v.) procedures (for example) we should use the term *trepanation* or *trepanning* instead of *trephining*; and *trepan* instead of *trephine*. (See, also, the medical dictionaries of Dorland, Duane, Gould and Foster). However, as these terms are

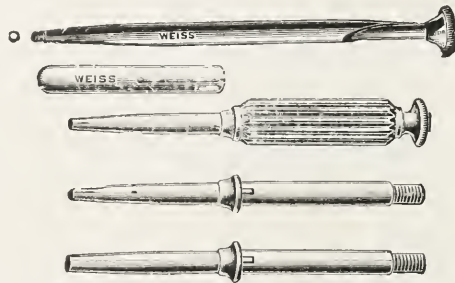
often confused or used indifferently in ophthalmic literature *trepanation* (and *trephination*) will be discussed under the heading *Trephining*; *trepan* under *Trephine*.

Trepanatio scleræ prææquatorialis. Holth's trephining operation for detached retina. See **Retina, Detachment of the.**

Treponema pallidum. A synonym of *spirocheta pallida* (q. v.).

Trephine. **TREPAN.** An instrument for the removal of a circular button or disc of bone or other firm tissue.

Ophthalmic trephines (sclerectomes, corneal, scleral or sclerocorneal trepines) have been to some extent already described and pictured under **Glaucoma**, p. 5530 (*et seq.*), Vol. VII and elsewhere in this



Sclerectomy Trephines. Bowman's (to the left); Stephenson's (to the right).

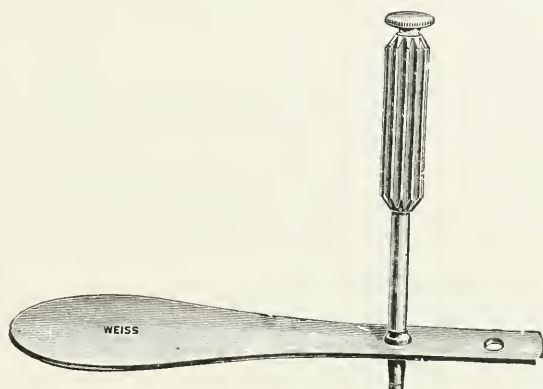
Encyclopedia. Further material on the subject is given here, in alphabetical order.

Bowman's trephine is described by Sidney Stephenson (*Ophthalmoscope*, June, 1910) in connection with his own modification of that instrument. He says that in employing the Bowman device there are certain drawbacks, one of the most important of which is the difficulty of holding the trephine securely. This was recognized by Argyll Robertson many years ago, and it induced him to devise a trephine provided with a handle. Stephenson's instrument is made from solid steel and drilled. It carries a collar bearing a pin, which fits into the slot of the pinion-wire handle, and thereby prevents the latter from rotating. The handle is fixed by a nut, which screws on to the proximal end. The blades of the trephine are 1 mm., 1.5 mm. and 2 mm. diameter respectively, and, as shown by the illustration, each blade is furnished with a cap for its protection. One handle serves for the three blades. The whole set can be fitted into a neat metal case at a slightly increased cost. If only one trephine be required it can be supplied with a fixed handle.

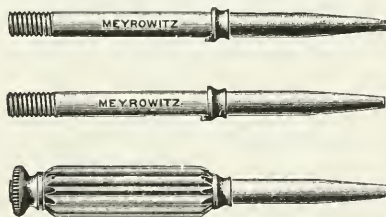
Cridland's sclerectomy trephine is depicted in the text.

Geo. A. Cross has invented a *sclerocorneal trephine* whose form is shown in the illustration. In general proportions, the handle resembles a screw driver used in fine mechanical work with a revoluble top cap. Somewhat below this top are three knurled rings, increasing in diameter from the top to the bottom. Below these three rings is the corrugated portion of the barrel.

The handle is made after this design so that it may be used in either of two ways. First, by placing the index finger on the movable cap at



Cridland's Sclerectomy Trephine.



The Fergus Trephine.

the top and twirling the corrugated cylindrical portion between the first and second fingers, or the instrument may be rotated between the thumb and forefinger, utilizing the three rings. The lowest of these rings being the largest overcomes any tendency of the fingers to slip down.

The trephine is secured in a split joint controlled by a screw cap and is supplied with a guard to prevent damage to the edge.

The *Fergus trephine* resembles the Bowman instrument. See the figure.

Killick's sclerectomy trephine. See the illustration.

Menzies' sclerectomy trephine is figured in this text.

TREPHINE

Brown Pusey (*Journ. A. M. A.*, May 17, 1913), has devised a trephine with a barrel of even diameter for 0.75 mm. from the cutting edge, then a slight flare, the object being to avoid the danger of cutting too deeply and also to avoid the interference of the turned-over conjunctival flap.

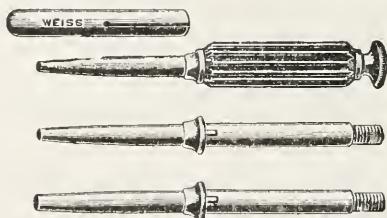
E. Rollett (*Revue Générale d'Ophthalm.*, 31 Dec., 1913), has devised an instrument which he prefers to call a *trepan*, not a trephine. It seems a complicated device, being constructed with the handle at right angles to the cutting tube, and is worked by a screw.



Killick's Sclerectomy Trephine.



Menzies' Sclerectomy Trephine.



Stephenson's Corneal Trephine.

The cut shows the cap at top, complete instrument with small trephine shaft under it, and two larger trephines below.

Stephenson's scleral trephine has been pictured elsewhere; here is reproduced a slightly different drawing of this convenient instrument.

Verhoeff's sclerostome (trephine) is described and illustrated on p. 5565, Vol. VII of this *Encyclopedia*.

A. Vogt (*Klin. Monat. f. Augen.*, April, 1913) has described his instrument (a slight modification of the Elliot trephine), and reports two cases in which it showed its superiority over the manual trephine.

Ziegler's sclerocorneal trephine is a one-piece instrument, the handle being fastened permanently to the trephine. The hollow blade itself is made from a solid piece of steel, and has been given a shape to facilitate resharpening. The instrument measures 2 inches over all, and

the circular cutting edge is $1\frac{1}{2}$ mm. in diameter. A tubular guard is furnished with each instrument to protect the blade.

See, also, **Trephining**.

Trephining. TREPANATION. TREPHINATION. OCULAR DECOMPRESSION. This subject should be read in conjunction with the sections **Sclerectomy**; **Trephine**; **Sclerocorneal trephining**, **Retina**, **Detachment of the, Trephining**, **Sclerocorneal** and **Glaucoma**.

This operation—the removal of a disc or button of sclera, cornea or sclero-cornea by means of a special instrument—is commonly done for the *relief or cure of glaucoma*, yet it is employed in the treatment of a number of other ocular diseases, *conical cornea*, *staphyloma*, *retinal detachment*, *retinitis pigmentosa*, etc.

First, *its employment in glaucoma* has already been extensively discussed, fully illustrated and brought up to date under the various captions above mentioned. The reader is referred to these sections. Here will be added a few further general observations.

A. C. Hudson (*Royal Lon. Ophth. Hospital Rep.*, Jan., 1914) examined microscopically and described a couple of cases of *detachment of the choroid* following sclero-corneal trephining. He believes that serious detachment, in varying degree, occurs in all cases of perforating lesion of the eye involving escape of the aqueous humor. The systematic review of an extensive series of pathological preparations carried out by the author not only confirms the foregoing supposition, but leads him to conclude that it embraces all cases in which a considerable reduction of intra-ocular pressure is present. The writer concludes:—
1. That serous detachment of the choroid and ciliary body is the natural accompaniment of considerable reduction of the intra-ocular pressure, and that its occurrence is the rule in every case of sustained reduction of pressure. 2. That the degree of the detachment varies, more or less directly, as the degree of reduction of the intra-ocular pressure. 3. That the fluid responsible for the detachment is derived probably from the choroidal blood-vessels and not improbably from the veins. 4. That the reduction in intra-ocular pressure is the chief factor in the causation of detachment of the choroid and ciliary body in shrunken eyes; whereas an increased intra-ocular pressure may suffice to counteract, completely or in part, the tendency of a cyclitic membrane to produce such detachment by traction.

Quackenbos (*Arch. of Ophth.*, 43, p. 600) reports the *complications and failures in 100 cases of glaucoma operated on by corneo-scleral trephining*. The operation was done in acute, hemorrhagic cases, secondary to trauma, and in congenital, and chronic cases. A 2 mm. tre-

phine was the instrument of choice. Three of the patients were operated on twice. The conjunctiva was buttonholed twice, but no bad effect was observed. In no case did the trephine button fall into the anterior chamber. The writer found it comparatively easy to do an iridectomy and believes it should be done in all cases. There was loss of vitreous in three cases, with no interference with the success of the operation. Quiet iritis occurred in a few cases and the author believes this to be the principal danger to be guarded against immediately after the operation. In two cases of simple chronic glaucoma there was a severe iridocyclitis. Atropin was used only in cases showing signs of inflammation. Persistent low tension occurred in one case. Separation of the choroid occurred in one case, and late infection in one case. Ten cases were not relieved by operation, and most of the cases that came to enucleation were of the hemorrhagic type. Quackenbos concludes that the operation is best adapted for cases of simple chronic glaucoma. It is not difficult and can be performed with little danger; an iridectomy should be done if possible, the conjunctival flap should be sutured, and a sharp watch should be kept for iritis. Late infection is a serious danger.

M. Feingold (*So. Med. Journ.*, Feb., 1918) has shown that even a well developed *late infection after the Elliot operation* is not necessarily disastrous. In two such instances the patient recovered with good vision and the writer remarks that his cases, as well as several instances in the literature, seem to indicate that late infection, even if recovery occurs, has a tendency to make the scar more firm and thereby renders a return of the increased tension probable.

The data on hand at the present time are entirely insufficient to permit any deductions what rôle the various micro-organisms play in late infections. All we can do now is to surmise that different micro-organisms are probably responsible for the different forms of late infection. That such varieties of the disease exist is evident from the different end-results of the different varieties of late infection.

Feingold then proceeds to tabulate (as follows) the cases in which the result can be classified with any degree of certainty. They are comparatively few in number; and only those are incorporated in the following table which contain cases of late infection following all forms of scleral operations for glaucoma. As "cured" are classed below all the cases when the result is called "cure," "iritis," "diminished vision." "Loss" is understood when the outcome is mentioned as "enucleation," "phthisis bulbi," "panophthalmitis," "poor outlook."

TREPHINING

13051

Cures	No. of		No. of
	Cases	Loss	Cases
Axenfeld	1	Axenfeld	1
Broder	1	Bronner	1
Bronner	2	Butler	4
Brown	1	Clegg	1
Butler	4	Constantinecou	1
Cramer	1	Gifford	1
Crouch and Clapp.....	1	Greene	1
Guglianetti	1	Griffith	1
Herzau	2	Harms	1
Kuhnt	1	Isakowitz	1
Knapp	2	Meller	7
Lundsgard	2	Paul	1
Meller	1	Percival	1
Pagenstecher	1	Quackenbos	1
Stoewer	1	Schur	1
Feingold	2	Priestley Smith and Nor-	
		man Pike	1
		Stock	2
		Story	1
		Vossius	2
		Wagenmann	1
	—		—
	24		31

W. Gordon Byers (*Am. Journ. of Ophthalm.*, Oct., 1918) believes that the *histologic findings* explain the causes of the *failure of the Elliot operation*. In the first case, that of a woman aged thirty-one, a scleroecorneal trephining was done, with a complete iridectomy. No complications followed. Nine months later the patient returned, stating that the eye had become suddenly painful shortly after she had left the hospital; but that pregnancy and childbirth had prevented her return sooner. Examination showed a marked congestion.

The bleb over the opening was collapsed, the lens dislocated, and the broken conjunctival covering mixed with uveal tissue. In the area of the coloboma upwards, occupying about one-third of the space, was a small, tongue-shaped patch of corneal infiltration, with its base resting on the limbus. Enucleation was performed. The microscopic examination revealed changes that were, in an exaggerated way, those that are characteristic of healing corneal wounds, with a marked response to injury or infection on the part of the uveal tract. In contrast to the

second case, the dislocation of the lens and the tearing of its capsule in this case were attributable to the sudden reduction of intraocular tension following collapse of the bleb.

The second case was that of a lady of eighty-three years, very active for her age, in whom a sclerocorneal trephining was performed with no complication except a slight difficulty in doing a partial iridectomy. The patient was perfectly comfortable until the morning of the eighth day following the procedure, when there were three short separate periods in which the patient saw light flashes, ushering in complete loss of sight. The eye became more and more irritable, with greatly heightened tension, necessitating enucleation. The specimen showed an ectatic scar, covering, dome-like, the site of the trephine opening.

The point of interest in this case was the vitreous prolapse. A brief study of the specimen showed clearly what must have been the course of events leading to its occurrence. The trephining was too peripheral. During the first few days, the uveal tract was sufficiently strong to support the intra-ocular structures; but it gradually stretched under pressure; and finally gave way on the eighth day, with consequent rupture of the annular fibers and hyaloid membrane, dislocation of the lens, and renewed tension following vitreous prolapse. The flashes of light were not due to retinal hemorrhage, as was supposed at the time of their occurrence, and no evidence of hemorrhage was found in any part of the specimen.

The lesson here is obvious. Especially in those advanced cases, in which accidents of this sort are prone to occur, Elliot's advice in regard to placing the trephine opening in corneal tissue should be followed to the fullest extent, in order to guard against the occurrence of the changes described. On the other hand, such procedure offers the best chance of securing unadherent iris for excision.

Verhoeff has examined a number of eyes that had been trephined unsuccessfully; and in the majority of them found that the trouble had been an injury to the lens. In a few cases of hemorrhagic glaucoma, the trephine hole had been closed by proliferation of tissue; but in the others, the result was due to injury of the lens, either by the instrument or capsule rupture. The small injury to the peripheral lens was unsuspected by the operator. Not until the eye was removed was it discovered. The whole trouble in these cases had been irritation by the cortical matter as it came from the lens. It makes a characteristic histologic picture; not an intense reaction, but a marked cellular exudation, associated with necrosis of the iris. In all the cases, the anterior chamber had become obliterated. The aqueous had been lost, and the space filled by this exudate of chronic inflammatory cells.

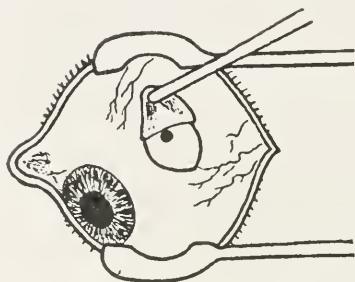
Edward Jackson has seen two unsuccessful trephinings that seemed due not to any error in the placing of the opening, but to the character of the cases. They were cases of chronic inflammatory glaucoma, that had gone on to practical blindness before operation was done. Although there was no question about the very high tension at the time of the operation, they were essentially uveal inflammations, and pursued a course that did not seem to be materially affected by the Elliot operation. Neither of these eyes was enucleated. They finally quieted down, with renewed high tension, but without pain. The operation gave relief from pain, but did not seem to alter the course of the disease.

Postciliary trephining. A. E. Ewing (*Trans. Oph. Section, Am. Med. Assocn.*, 1918) has tried this procedure in acute glaucoma with, however, no advantageous results. A postciliary scleral trephining was performed in the upper temporal portion of a globe 7 mm. from the corneal margin, a diagram of which is here reproduced. See the figure. In this procedure the eye is first anesthetized with holocain, 1 per cent., and cocain, 5 per cent., and a minim of 1 per cent. cocain solution is then injected hypodermically at the site of the intended opening in the sclera. After from three to five minutes an 8 to 10 mm. conjunctival flap is raised from below and the wound is located at the center of the base of this flap, which is placed preferably in the neutral region, either between the external rectus and the superior rectus, or between the external rectus and the inferior rectus muscles. The flap may be dissected from the sclera over its whole area, or the conjunctiva may be dissected to Tenon's fascia only as far as to the base of the flap, and here with scissors it may be cut through the fascia to the sclera at the site of the wound to be trephined. It has seemed that better drainage was obtained by the last method.

In this particular case the entire flap was dissected through to the sclera, and with a 2 mm. trephine the sclera was then trephined through the choroid, 7 mm. from the corneal margin. This membrane bulged into the wound but did not rupture. The conjunctival flap was then replaced by means of a suture at the apex, and the eye was cleansed with physiologic sodium chlorid solution and bandaged. Following the operation there was no appreciable reduction in the tension, as determined by palpation with the fingers. The operation was practically painless, and there was no subsequent pain. At the time of the first dressing, forty-eight hours later, the globe was very quiet, the cornea clearer than at the time of the operation, the pupil round and central and 7.5 mm. wide, there was a good reflex from all portions of the fundus; there were no details. Vision was reduced to fingers at 1 foot,

eccentric to the right. There was no appreciable change in the tension of the globe, but the patient remarked that the eye was "more comfortable than it had been in three weeks," because it had felt as if the globe was "too large for the socket." This discomfort had ceased. Under the constant use of physostigmin, 0.5 per cent., the vision returned to 20/60, eccentric to the right, during the succeeding four weeks, and the field was somewhat reduced in size. There was marked protrusion of the conjunctiva over the trephined area, and the opening in the sclera was readily seen through the conjunctiva and shown to be clear by transmitted light.

Sclero-corneal trephining for staphyloma of the cornea. The results of Elliot's trephining in seventeen cases are recorded by Reinhold



Postiliary Scleral Trephining for Acute Glaucoma. (Ewing.)

Location of the wound in the neutral region, midway between the superior and the external recti muscles.

(*Indian Med. Gaz.*, May, 1914). In thirteen the staphyloma was reduced by the establishment of free filtration between the aqueous in the anterior chamber and the subconjunctival tissue. No improvement of vision was obtained or expected in the majority of cases; all the patients but one were, however, pleased with the result and were relieved of an ugly deformity. In six cases vision was much improved, the distortion of images previously complained of being relieved. The operation is contra-indicated in cases in which it is suspected that the suspensory ligament has given way and the lens has ridden forward into the anterior chamber, for here there is not only liability of rupture of the lens capsule by the trephine (as happened in one case) but even if the trephining is successfully accomplished, the lens is apt to block the trephine hole, stopping filtration and so causing recurrence, as happened in two cases. In these cases, also, the hyaloid may be ruptured and the vitreous damaged. The conjunctival flap is taken from above and made as long as possible; the longer the flap the better the filtration. At the limbal edge great care must be exercised in splitting the

cornea, as it is often abnormally thin owing to stretching and previous disease. Should perforation occur before the trephine is applied, the operation is completed by iris scissors, cutting out a triangular piece of sclero-cornea to effect infiltration. A 2 mm. trephine is used, larger for very large staphylomata.

The iris does not usually prolapse, owing to disease and adhesions, so that this membrane, often brittle and bleeding, has to be pulled out with iris forceps. The blood may be subsequently washed out by McKeown's irrigator. A probe is passed into the anterior chamber to ensure free passage for aqueous. The flap is replaced and need not be stitched, unless it has been made below the cornea, when it is necessary. Both eyes are bandaged, and the first dressing made forty-eight hours later. Atropine is applied daily, to guard against iritis, and the eye operated on bandaged for eight or ten days. If filtration remains free the staphyloma, even if of large size (in one case so enormous as to make closure of the lids difficult) flattens down and the deformity is removed.

von Haselburg (*Oph. Year-Book*, p. 161, 1914) has reported a case of corneal trephining for the *relief of chalky cornea*. The cornea was completely opaque with calcareous deposits from frequent recurrent attacks of keratitis during childhood. With the von Hippel trephine a piece of cornea 0.5 mm. thick and 5 mm. in diameter was transplanted from a man 22 years of age, whose eye had to be removed for a painful injury. Care was taken not to include Descemet's membrane. The flap was fixed with threads and a bandage applied. A few days later it was quite opaque, but later became clear again. On June 25, 1914, the patient's vision was 1/60, and she was able to find her way about in the streets, which was not possible before.

Harold Gifford (*Ophthal. Record*, August, 1916) reports that he got a poor result in each of the two cases of *buphthalmos in which he did a trephining*. One patient was a typical two-sided case in a boy of about 5 years. The other a one-sided case of moderate degree in a woman of about 35. In both the operation itself was as easy as possible, but the reaction was somewhat prolonged and final result, so far as improvement went, was nil. No distinct bleb formed and the tension and eye-sight remained for the few weeks during which they were kept track of, as before the operation. Since then he has noticed that his experience is not unusual. Poor results from trephining in buphthalmos have been noted by a number of men who have been well satisfied with the operation in chronic glaucoma.

Quackenbos speaks of having to abandon an attempt to trephine in buphthalmos on account of the extreme thinness of the sclera.

Axenfeld and Lundsgaard object to trephining in buphthalmos on entirely different grounds; the former because these patients being so frequently young, have so much longer and greater chance in the years of their life to have late infection; and the latter because the greater damage of traumatic injuries to the bleb which children are subject to.

If we grant that the results of trephining in buphthalmos are unusually poor, what explanation can be given of the fact? Those who believe in the inflammatory origin of buphthalmos may regard it as evidence of a tendency to plastic reaction by which the trephine hole is closed. It seems more probable to Gifford that on account of the excessive enlargement of the globe, the conjunctiva, especially at the limbus, must be applied abnormally tightly to the globe, hence, when, after trephining, healing is complete, there must be unusual resistance to the formation of a bleb and an abnormal tendency for the conjunctiva to block the trephine hole. This suggests the probability that in buphthalmos it would be well, so far as the location of the trephine hole is concerned, to pursue a policy just opposite to that followed in normal cases. Since the attachment of the conjunctiva to the globe is looser at the posterior than at the anterior margin of the limbus, instead of putting the hole as far forward as the abnormally wide limbus will allow, one ought to put it as far back as possible and still keep the inner side of the hole within the chamber.

Trephining in retinitis pigmentosa; see end of the section.

Trephining, Postciliary. See **Trephining**.

Trephining, Sclerocorneal. ELLIOT'S OPERATION.

[Owing to continued improvements in the technic of this important procedure, it is again described (see **Glaucoma**) from recent data, including illustrations, furnished by Colonel R. H. Elliot, to whom the Editor is indebted for the courtesy.]

The criticism has been offered that this operation has been said to be easy, but is often difficult. Those with a fair amount of technical experience will probably find it from the start a very easy procedure; but, like all other operations for glaucoma, it may at any time prove a difficult one in advanced and hazardous cases. When the author left India, the Madras figures showed over 900 cases. Since then he has had the opportunity of trephining a large number of eyes in America and in England, and has had the advantage of receiving valuable suggestions from surgeons, who are trephining cases all over the world. In the light of this assistance, certain minor details have been modified. Although the technique will now be described in considerable detail, it must not be thought that the operation is a correspondingly complicated one. The author has seen so many instances in which sur-

geons, who believed that they were adopting his method, were unwittingly omitting, or changing important steps in the procedure, that he has decided to describe it as fully and clearly as possible.

(1) *In which quadrant of the eye should the trephining be performed?* It is obvious that under most circumstances the upper is the quadrant of choice, for (1) the wound is then less exposed to infection; (2) the iridectomy, if one is performed, lies under cover of the lid; (3) the conjunctival flap rarely requires a stitch when made above; and (4) Rochon-Duvigneaud has shown that the measurement from the angle of the anterior chamber to the limbus is greater in the vertical than in the horizontal meridian, and greater above than below the cornea. This is due to the varying distance that the conjunctiva overlaps the cornea, which it does to the greatest extent above. The consequent advancement of the limbus in this direction gives the operator a proportionate increase in the amount of room available for the implantation of the trephine, without risk of doing damage to the ciliary body or to the adherent iris. It is not, however, possible to trephine above the cornea in all cases, and it is inconvenient to do so in some others. When a patient is troublesome, and looks obstinately upwards, it is a great convenience to do the trephining below: the efforts to defend the eye, by looking upward, then aid the operator instead of hindering him. This difficulty usually occurs in those who are already practically blind, and in them the presence of an iridectomy-coloboma within the palpebral aperture is of no consequence.

There are at least three other sets of conditions in which it is not possible to trephine above the cornea, viz., (1) when the operation is undertaken for the relief of staphyloma, and the upper part of the cornea is involved in the swelling; (2) when, in chronic cases, it is obvious that the chamber is shallower in an upward direction than elsewhere; and (3) when a condition similar to the last named is due to anterior synechia, accompanied by rise of tension. In most cases of partial staphyloma one can find an area in which the chamber can safely be tapped, and the same applies to the other two conditions mentioned above. The difference between the depth of different parts of the chamber in some cases of chronic glaucoma is very striking.

(2) *The nature of the flap, and the method of making it.* Something has been written about the danger of wounding Tenon's capsule while raising the flap, but it is hard to believe that any operator could be clumsy or careless enough to do such a thing; it is no real danger to the man of ordinary knowledge and skill. The underlying suggestion has evidently been that it would be safer to reduce the size of our conjunctival flaps. This is a subject which has engaged much at-

tention, and our decision has been to hold on to the large flap for the following reasons: (1) it is a great safeguard against infection of the eye; (2) a negative point—our observations show us that we do not meet with any astigmatism in consequence of it; this has been proved by careful keratometer readings; and (3) the really important matter—large flaps mean free and easy filtration. A careful study of a number of cases after operation shows that the actual line of the incision is sometimes tied down on to the sclera; if one makes a flap of little length, it tends to curl in on itself; moreover, if the two ends of the incision reach the cornea, and if the line of union then cicatrizes, it is obvious that the total area left for filtration is very limited (vide Fig. 1). A more generous flap is more inclined to lie in place, and is for

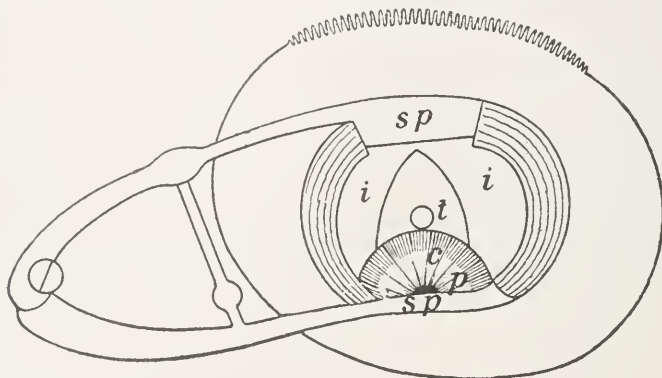


Fig. 1. Elliot's Operation. The Incision, in the Early Technique.

this reason less apt to cicatrize at its edge, as it unites with the conjunctiva, from which it was cut, and not with the subjacent sclera. This helps to provide a larger area of subconjunctival tissue into which filtration can take place. A more important detail still remains to be mentioned. The incision we now employ does not begin and end in the limbus, but runs roughly concentric with it, and ends on either side opposite the highest point of the cornea, and about 8 mm. to its inner and outer sides (vide Fig. 2). The importance of this detail is obvious, for even if the line of incision cicatrizes down all round, filtering fluid from the interior of the eye can still find a free exit through the trephine hole into the subconjunctival space outside the incision limits through the areas marked aa in Fig. 2. An important confirmation of the value of this form of flap was obtained in an early case, in which we were obliged to open up the wound some time after operation, in order to excise prolapsed iris. The line of incision was bound down to

the sclera, but the moment we crossed this line in opening up the flap, free escape of filtering fluid took place into the wound.

In making the conjunctival flap, one should avoid the brow with the scissors; if this be not done, the eyebrows will be cut and dropped on to the wound, thus soiling it. In order to make the description of this important part of the operation clear we may divide the "fashioning of the flap" into the following stages:

(i) *The incision.* The conjunctiva should be seized as high up as possible on the bulb with forceps, and drawn well down, at the same time asking the patient to look strongly downward; one free horizontal

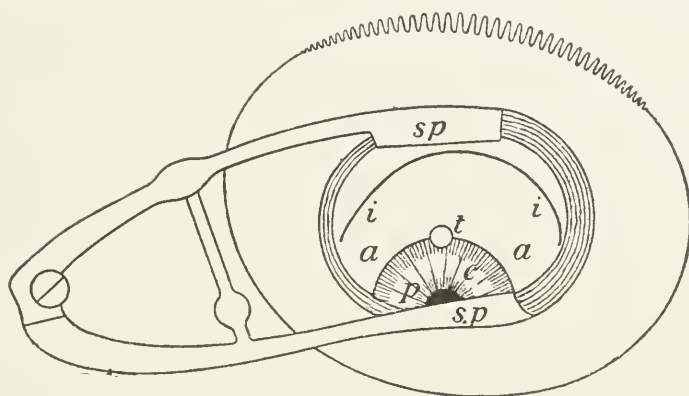


Fig. 2. Elliot's Operation. The Incision, in the Present Technique.

Sp, Speculum; *ii*, incision; *c*, cornea; *t*, trephine hole; *p*, pupil; *aa*, channels in conjunctiva along which filtration fluid passes to enter the main area of the subconjunctival space.

cut, followed by a couple of snips at each side, will often outline the flap throughout its extent; the shape and dimensions, etc., of the flap have already been given.

(ii) *The dissection of the flap.* It is unnecessary, and therefore unsurgical, to dissect up the whole area included in the flap; moreover, by so doing we rob the flap of the check-ligament-like action of the connective tissue at the angles of the wound (Fig. 3. efa). If we leave this tissue intact, the detached conjunctiva tends to spring back into place when released from the downward pull, whilst if we clear the margins of our wound, we find that at the end of the operation, the flap falls limp and inert over the cornea like a loose apron. We should for this reason carry out our dissection down to the limbus over the central area only (Fig. 3. edde). Such a procedure does not in the least prevent us from exposing the area we require for trephining, whilst it helps very materially to make our flap lie in good position when the opera-

tion is finished, and so often enables us to dispense with the use of a suture. In the upper portion of the dissection, we do not need to take up anything but the loose conjunctiva. As we approach the limbus we should work down to the sclera, and should expose the latter bare in the last few mm. of the wound (Fig. 3 fddf). At the same time the breadth of the dissection should contract as we approach the cornea, so that when we reach the latter, we only expose just such a breadth of it as we mean to split, and very little more (Fig. 3. dd). Our next

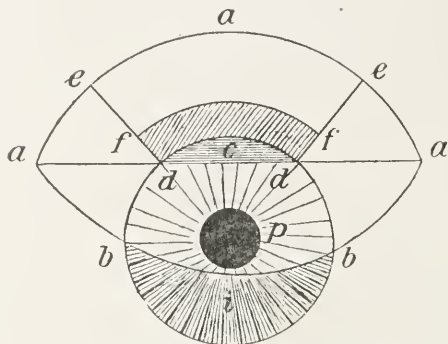


Fig. 3. Elliott's Operation. Diagrammatic Representation of the Area Laid Bare by the Conjunctivo-Corneal Flap.

aaa, Line of conjunctival incision; *abba*, flap thrown down on the cornea; *e*, dark arc-like area of split cornea; *dd*, straight line of reflection of the flap; *edde*, area dissected up in order to enable the cornea to be exposed; *effe*, area of the upper part of the wound from which the conjunctiva alone is dissected up, when commencing to make the flap; *fddf*, area immediately above the limbus cleared right down to the sclera, in the course of the dissection of the flap; *ade*, the area on each side in which the subconjunctival tissue is spared as much as possible in order to preserve the check-ligament-like action which helps the flap to lie in good position after the operation is finished; *i*, iris; *p*, pupil.

landmark is the limbus, and we must clearly define this as a rounded ridge slightly overhanging the adjacent sclera. A failure to do so involves a considerable risk of difficulty when we come to split the cornea in the next stage of the operation. If, however, there has been long-continued chronic congestion, it may be difficult to define this edge, as it then flattens out; in that case the earlier stage of splitting of the cornea must be very carefully conducted, or the flap may be button-holed. The area over which we are about to apply the trephine must be carefully cleared of all tags of loose tissue; if this precaution is neglected, the trephine will not bite well, and will tend to shift from its position; moreover, when it does begin to cut, these tags may get caught in the action, and tend to draw the flap into the wound and

damage it. The author has seen this happen to beginners. There is a little knack in getting the sclera clear; this consists in closing the blades of a sharp-pointed scissors (those we have used so far in the operation), and making a number of scraping movements from the centre of the wound out to each side, close above the cornea; this manoeuvre succeeds in clearing the central area of loose tissue, and so provides a clean surface on which to apply the trephine blade, at a later stage of the operation.

(iii) *The splitting of the cornea.* It must first be clearly stated that what we desire to do is to split the cornea, and not to cut it. The examination of microscopical preparations has shown that that membrane is really split, and that the flap we make includes not merely the anterior epithelium, and Bowman's membrane, but also some of the superficial corneal lamellæ, which can be traced for a long distance in the sections and can be seen to be separated from the deeper layers. The significance of this observation lies in the fact that we are thus enabled to open up the planes of the lymphatic spaces, and to keep them bathed, and unhealed, in the fluid which is steadily being poured out from the anterior chamber. The observation has been made by those who cut, instead of splitting the cornea, that if they carry their trephine blade right on to the cornea, the hole tends to fill up. It is suggested that this is due to the cornea having its lamellæ cut clean across, instead of having its interlamellar spaces opened up by splitting; for we have had a more fortunate experience after splitting the membrane in the way we are about to describe.

The conjunctival flap should be drawn gently downwards by traction with closed forceps laid on it, and finding counter-pressure against the cornea; it must on no account be seized in the grip of forceps and pulled down therewith, or it may easily be torn and rendered useless for its purpose of covering the filtration hole. At the same time, the cornea is split with the scissor points, which are kept closed for the purpose; or, if preferred, a Bowman's needle, or a special wedge-shaped splitter, as devised by McReynolds, or any other convenient instrument may be employed. The most important point is to work at exactly the right place, i.e., just behind the line of reflection of the flap; a number of short purposive lateral strokes along this line speedily effect our purpose in most cases. If the cuts are made too far forwards, the flap is at once button-holed, whilst if they are made too far back, the surgeon merely wastes his time in an ineffective scratching of the sclera. The instrument is inclined at an acute angle to the cornea, bearing in mind that what we want to do is to dissect off its superficial layers in a thin flap. It is very necessary to have good eye-

sight and a good light, though granted these two requisites the technique is not difficult. The author's own preference is very strongly to work by daylight, but if an artificial light is used, it is essential to have an additional small hand lamp which can easily throw in a beam sideways when required. The reflexes obtained by artificial light off the parts are most confusing and annoying, whilst in daylight the work is easy and pleasant. As the dissection proceeds the so-called "dark crescent" of cornea can be seen clearly (Fig. 3 c) as a dark area convex in outline towards the sclera, and with a straight edge on the corneal side. The figure produced is that of a small segment of a circle, in which the reflection of the flap forms the chord (dd), whilst the edge of the stripped cornea corresponds to the arc; a good simile is that of a bow and its string. If in the course of the dissection one sees the line of flap no longer curved at the corneal margin but crossing it in a straight line like the string crosses a bow, we may rest assured that the cornea has been split; this suggestion is not without value, for in some eyes the cornea shows up much less dark than it usually does, and an inexperienced operator, unaware of this fact, may fear he has not split the cornea, and may persist till he button-holes his flap. In the very great majority of cases we can split the cornea easily for 1 mm.; in not a few the splitting may be carried 1.5 to 2 mm. on to the corneal tissue; in a few cases, and especially in those with long-standing congestion, it is difficult to get a crescent wider than 0.5 to 0.75 mm. Although this latter amount can always be secured, it sometimes is only done by tearing rather than by splitting. Such cases are fortunately rare; they occur in eyes which have been the subjects of long-standing congestion, and the prognosis for the maintenance of fistulization is not so good as it is in the ordinary cases.

There are two other conditions under which one finds a difficulty in splitting the cornea, viz., (1) that in which the conjunctiva is found to be tied down to the sclera, as the result of the use at some previous date of irritating subconjunctival injections in the quadrant we are operating in, and (2) that in which the subconjunctival tissue of the eye is found to be unusually dense and abundant. In connection with the former condition, our experience has been that any and all of the subconjunctival injections cause the formation of adhesions, as judged by our findings at the time of operation, but that normal saline injections do so far less than those of sodium citrate or of the mercurial preparations: in the case of either of the latter, the adhesions are usually so dense as to make the approach to the limbus difficult, and the splitting of the cornea almost impossible. The obvious lesson is to avoid the injection of any fluids into the area which we may later on

need to use for operative purposes. As to the second condition above discussed, we have found that there is a very great variation in the amount of subconjunctival tissue in the eyes of patients even of the same age, and that the scantier this tissue layer is, the easier is it to split the cornea, and vice versa.

An important question and one often asked is, how is the operator to tell when he has dissected far enough forward, and when there is a danger of button-holing his flap? We must bear in mind that the object of splitting the cornea is to enable us to place the trephine as far forwards as we safely can. Now an experience of a large number of cases has shown us two things, viz., (1) that on the average, one can safely split the cornea a little over 1 mm., and (2) that such an area of splitting puts us practically in a secure position so far as the danger of trouble from the iris or ciliary body is concerned. To this we may add that it is possibly not desirable to have the whole of our trephine aperture sited on the cornea. Apart from all these considerations, if the surgeon sees that his flap is getting too thin at the edge, he will do well to be content with the amount of splitting he has accomplished, and not to risk button-holing. So much has been written about the latter accident in connection with the splitting of the cornea that it is necessary to point out that the danger of its occurrence is certainly not great at this stage of the operation. It is more likely to occur when the trephine is actually being used, and still more so when the iridectomy is being performed.

In connection with the manœuvre of splitting the cornea, there is a small point of some interest; it will be observed, especially in those cases which split easily, that one part of the line we are working on gives more readily than the rest, producing the appearance of a bite out of the straight edge of the flap-reflection, or that of a small shallow bay in it. The importance of the observation is that it is much easier to continue the splitting at one of these bays than elsewhere along the line. In conclusion, it is important to lay emphasis on the fact that the split area has a smooth appearance, indicating that we have dissected up along a plane of cleavage. This is what we have always believed we have been doing, and recent anatomical work has shown this belief to have been justified.

This manœuvre of splitting the cornea has been very minutely described at the special request of a number of surgeons, and it is hoped that it has now been made quite clear. At the same time, one desires to avoid giving any support to the views of those who maintain that splitting of the cornea is a very difficult procedure; it is true that it calls for care and skill, but that is all that need be said of it. To prove

this point, we may quote some figures from our statistics in Madras. In 201 consecutive trephinings (between November, 1911, and March, 1912) the writer damaged his flap on four occasions only (i.e., in 1.99 per cent.), and in not one of these cases was there any evidence that the tiny button-hole made had any influence on the satisfactory course of the case. During the same period ten other surgeons, learning trephining in Madras, button-holed seven times in 124 consecutive operations (i.e., in 5.6 per cent.) and on only one such occasion was it found necessary to shift the area for the application of the trephine.

When we started to practise "splitting of the cornea," the objection that first occurred was that the close attachment of the corneal conjunctiva to the deeper layers would cause these parts early to become firmly reunited, and that consequently the corneal area of the wound would be lost for filtration purposes. Experience has clearly shown that such a fear was wholly unfounded. Indeed, the part of the wound overlapping the cornea has proved to provide a free and ready area of filtration with no tendency such as we had feared.

(3) *The application of the trephine.* With increasing experience one thing has become absolutely clear, viz., that if we wish to trephine the chamber, and to establish a permanent filtering channel with a minimum of trouble, we have to be careful to place our trephine hole as far forward as possible.

A failure to observe this rule (1) makes a clean entry into the chamber uncertain; (2) complicates the free tapping of the aqueous fluid; (3) leads later on in some cases to an interference with filtration, due to uveal tissue blocking the trephine hole; and (4) exposes the eye to the danger of vitreous escape. If the trephine hole is far forward, the only part of the uveal coat with which we have to do is the iris, and this can easily be dealt with, as we shall show later on. If the iris base is adherent to the cornea, the advantage gained by placing the trephine hole as far forward as possible becomes still more obvious; hence the urgency of the need for dissecting the conjunctivo-corneal flap forward in the way already described. In applying the trephine we must not throw away any of the advantage so gained; the flap should be pulled gently towards the center of the cornea by traction exerted with the points of the closed forceps, and the trephine placed on the prepared corneo-scleral surface so that its edge will just clear the flap, thus making use of every fraction of a millimeter of the area which has been gained by the splitting; the dark crescent of corneal tissue bordering the base of the flap can very easily be seen and defined.

The trephine should not be dumped down on the spot on which it is to work, but should be slid into place from the scleral side, the edge

of the flap being keenly watched the while; this manœuvre greatly minimizes the risk of button-holing the reflected edge.

The beginner may find some difficulty in keeping his cutting edge to one spot at the commencement of the trephining. As a rule, this manœuvre becomes quite easy with a very little practice, especially if a sharp instrument be used. The surgeon may obtain considerable assistance by seizing the trephine blade low down, close to the eye, in the grasp of a pair of conjunctival forceps, and thus fixing the cutting edge of the instrument. With a little practice, however, he will learn to trephine freely and evenly without feeling the need of employing any device to steady his blade.

Some of the surgeons who worked in Madras preferred to discard any trephine-steadier, and instead to fix the eye by gripping it with forceps at one angle of the incision, asking an assistant to draw the flap downwards over the cornea by means of any convenient blunt instrument. There can be no doubt that this modification of technique is greatly appreciated by those who make a practice of using it.

The *exact amount of pressure necessary* can only be learned by experience; some beginners appear afraid of using enough force and needlessly lacerate their wound by niggling efforts on different spots, the trephine slipping from one place to another each time they reapply it; others, but they are very few in number, go through with an overbold confidence and find themselves in the vitreous chamber before they know what they are doing. In order to avoid both these errors, it is necessary (1) to work in a good light with a very sharp trephine; (2) to keep the area of operation clear of blood, so that the operator can see exactly what he is doing; (3) to make sure of cutting a definite groove on the first application before raising the trephine to see what has been done; and (4) if necessary, to steady the trephine blade and keep it to one spot by seizing it gently, quite close to its cutting edge, in the grasp of a pair of conjunctival forceps. Once a definite groove has been started, the blade finds its way into it again with astonishing ease; from this stage onwards the operator, until he has acquired the necessary experience, must raise his blade frequently to see how deep he has cut; with practice this will become unnecessary, and he will then be able to tell when he is through by the sucking feeling which accompanies the completion of the trephining; at the same time aqueous may often be noticed to escape around the instrument or through its lumen, and frequently the patient by a slight movement or by an exclamation shows his consciousness of a little pain; this latter is not severe, and he never starts violently because of it; a movement or an exclamation is all that escapes him. There is a fourth sign to which attention has

been drawn by Axenfeld, Hill, Griffith, Wallis and others, viz., the upward movement of the iris at the moment the trephine cuts through, which results in the production of a pear-shaped pupil; this is evidently due to the outrush of aqueous from the chamber, carrying the iris along in the direction of its current. For the detection of this sign it is necessary to hold the flap at right angles to the eye whilst the trephine is cutting its way through. The correct use of the trephine by light, steady cutting strokes requires learning, and can be easily practised on the eyes of animals. The author, when using the earlier form of light handle, worked with the index finger and thumb, and constantly moved his fingers up the instrument as they tended to slide down; it is this downward slide of the fingers which gives operators most trouble at first, and some require to use a second hand each time they move their fingers back into position again. The adoption of the heavier handle which we now use has greatly simplified this part of the technique. No pressure need be used, as the instrument works by its own weight, and consequently the tendency of the fingers to slip down is practically abolished. All the instrument makers who manufacture the author's trephine have been requested to supply in future the heavier weight of handle, viz., one of 2.5 drachms (9.7 grammes).

The direction in which the blade of the trephine is to be held relative to the corneo-scleral surface is a matter of great importance. It is to be remembered, that in the neighborhood of the limbus, the cornea is thicker than the sclera. If, therefore, we hold our blade perpendicular to the surface (i. e., radial to it), we penetrate the coat first on its scleral edge. Now for a double reason this is exactly what we wish to avoid doing, for (1) our one great aim throughout this technique is to place the fistula we are endeavoring to establish as far forwards on the eye as we can; that is to say, as far as possible from the ciliary body or from adherent iris; this can obviously be best attained by cutting steep into the anterior chamber on the corneal edge of the wound; and (2) when we come to speak of the division of the hinge left at the close of the trephining, it will be obvious that so far as the reflected edge of the conjunctivo-corneal flap is concerned, this will be more safely and easily avoided, when we are cutting through the hinge, if the latter lies the breadth of the opening away from the flap, than if the two are contiguous. In the latter case the danger of button-holing is obviously much increased. Our object should therefore be to make the blade cut through first on its corneal edge, and in order to ensure this, we must slope the upper end of the instrument a little towards the patient's feet. The result will be that as soon as the trephine has cut its way through, the disc, hinged on its scleral side, will be pushed up-

wards and outwards by a bead of iris tissue, prolapsing through the corneal side of the opening. If the manœuvre is correctly carried out, this prolapse occurs with great regularity. It is, however, dependent on two factors, (1) the presence of a moderately contracted pupil before the operation is commenced, and (2) the use of a sharp trephine. It is important that the pupil be at least not dilated, for one finds that when dealing with dilated pupils, it may happen that the iris may bulge through so far that its free edge presents in the hole and allows the escape of all the aqueous fluid, in which latter case the membrane will very likely fall back again into the chamber, making a subsequent iridectomy both more difficult and more hazardous.

The next question of importance is *the size of trephine* to use. We have tried all sizes from 3.5 mm. down to 1 mm., and our personal preference is in favor of a 2 mm. instrument. An opening of this size is practically always large enough, whilst a smaller one has this grave disadvantage—that it does not give room for the use of iris forceps and scissors, should the iris happen to be accidentally dragged into the wound and impacted there. In the event of repeated trephining with a 2 mm. blade failing to keep the drain open, we may try a larger instrument. As an experimental measure, we have tried this in occasional and rare cases.

In our earlier experience with the trephine we found ourselves constantly confronted with the difficulty of deciding whether the whole disc marked out by the instrument should be removed or not; we realized that we were between the dangers of removing too much and too little. If in a recent case we take the whole 2 mm. disc away, we may find that the tension remains very low for a long time, possibly indefinitely; on the other hand, if we do not take the whole disc away in chronic congestive cases, the hole is likely to fill up, and filtration may thus cease. With a very little experience of the 2 mm. trephine it will be found possible, provided the instrument is sharp, to detach the disc the whole way round, or to leave it uncut at one small hinge only; in the latter case a single snip of the scissor points does the rest. If we wish, we can cut off any desired portion of the disc, thus removing a third, a half or more of it at will. The same end may be more neatly and methodically attained by deliberately pressing yet a little more on the corneal edge of our trephine, and so entering the chamber round a half or more of the circumference on that side, thus leaving a comparatively large hinge uncut; in completing the detachment of the disc, we formerly cut across the hinge obliquely with the deliberate intention of leaving the deeper layers of this part in situ. Further reflection has showed that this last procedure is not above criticism,

since it must obviously leave the tunic of the eye unnecessarily weakened at that spot. We now determine how much of the disc we intend to remove, and cut it off at right angles to the surface, thus leaving the posterior edge of the fistula we aim at making as steep as its anterior edge, which has been cut with the trephine. There is no difficulty in carrying out this manœuvre; all that it is necessary to do is to draw the hinge well away from the eye, and to cut with the plane of the scissor blades at a tangent to the eye, and as close to it as possible. On the contrary, if we do not pull the disc well out, and if we cut with the scissors directed obliquely to the eyeball, we shall evidently cut the hinge obliquely, the very contingency we desire to avoid. It may be urged that we are sacrificing a part of the area of our wound in the sclera, and had much better have diminished the size of our trephine to begin with. The question is, however, not quite so simple as it looks, for we can never in any case say beforehand that the iris will not give trouble by becoming impacted in the wound during or after the performance of the iridectomy; and although this accident is not a frequent one, it must be thoroughly dealt with if met; it is quite an easy matter to resect the deeper layer left, by using a pair of small disc forceps and the scissor points, and we are then in the position of being able to deal easily with the offending iris. Similarly, if during the trephining—and with a blunt instrument this may easily happen—we accidentally leave a part of the deeper layers when we meant to remove them, the manœuvre above described enables us to do so quickly and easily. If the trephine blade is sharp, and the operator finds that, though he has tapped the aqueous, possibly only at one point, the main circumference of the incision still remains uncut, he may re-insert the trephine, and working with light, quick movements may complete the removal of the disc, even though the chamber may have been practically emptied beforehand. The patient will complain of some pain whilst this is being done, but it is not severe. In any case the application of a crystal of cocaine to the wound right over the trephine hole will make the part absolutely anesthetic.

There is undoubtedly another side to this question, which we may put thus: (1) Since we have made splitting of the cornea a regular feature of our *technique*, the trouble we formerly had with the iris in the wound has practically disappeared; there can be no doubt that the method of seizing the disc and iris together during the iridectomy has contributed materially towards this happy state of things; (2) our anatomical measurements of the space available for trephining, without interference with adherent iris, or with the ciliary

body, have shown that this is limited, and that in case the iris is adherent the limitation becomes still more marked; (3) a reduction of the diameter of the trephine blade to 1.5, or even to 1 mm., did not prevent our getting excellent and permanent filtration in a number of our early cases; and (4) we must not lose sight of the fact that for any definite length of wound, a circular incision gives the maximum of surface area, and therefore the minimum possible of weakening of the ocular tunic. It may then be argued that we shall do well to reduce our trephine blades if we possibly can, and in rare cases we make a practice of doing so, but rightly or wrongly our leaning is still strongly towards the use of the 2 mm. blade.

(4) *The iridectomy: its nature and the method of performing it.* An iridectomy should be made, as a routine step, in every trephining operation, simply to avoid the risk of iridic tissue becoming impacted in the trephine aperture during convalescence. The rôle of an iridectomy in this operation is the same as it is in the combined extraction of a cataract; no more and no less. It provides a sluice-gate through which rushes of escaping fluid can take place, without carrying the iris in front of them on their way out. This view of the case has been combated by certain ophthalmologists, but it is borne out by the fact that our experience and that of many other surgeons has shown that cases in which no iridectomy has been performed, have provided just as efficient filtration as those with iridectomy, provided always that the hole remained iris-free. It also has the sanction of Lagrange's consent. It is obvious that all that it is absolutely necessary to do is to remove a small peripheral portion of the membrane right opposite the trephine hole.

It is a common experience that the trephine disc, when cut by hand, nearly always remains attached at one point to the scleral coat by a narrow hinge. With a little practice it is possible, as indicated in the last section, to so trephine that the hinge is regularly left on the scleral side of our wound. When this is done with a sharp trephine, which cuts its way through around a large area at once, we find that the iris bulges into the hole as soon as we withdraw the instrument. If this prolapse is watched, it will be observed that the most peripheral part of the iris is the first to pass into the hole; this is exactly what we should expect from its anatomical position. If the patient squeezes, more and more of the membrane bulges, till at last the free edge of the iris protrudes, the aqueous escapes, and the membrane, now relieved from the *vis a tergo*, drops back into the chamber again. This sequence of events depends to a great extent on two factors, viz., (1) the peripheral position of the wound, and

(2) the state of contraction of the pupil. For the prolapsing iris to fill the trephine hole in this way it is a necessary condition that it should be free and untethered; it must also be in a state of moderate contraction, or the pupillary edge will early present in the wound, the fluid will escape, and the prolapse disappear. The appearance of the little white disc, pushed upwards by the small black bead of iris, is unmistakable, and it is an easy matter to include both disc and iris in one grip of the forceps, and to divide both together with a single snip of the scissor points, thus performing our iridectomy with the same cut that severs the hinge. The great advantage of this is that our grip of the disc steadies the eye, and effectively prevents even a troublesome patient from rotating it until after the portion of iris has been removed. We are thus enabled to avoid all risk of the uveal tissue being dragged into and becoming impacted in the trephine hole.

One finds that one has sometimes made a complete, and at other times a peripheral, iridectomy. The former is attended by certain disadvantages, viz., (1) it tends to cause blurring of images, (2) it may expose the patient to some "dazzling," and (3) it deprives the surgeon of the power of producing strong miosis, should he subsequently need to do so. When the pupil has been small before operation, and the prolapse of iris is not large, the resulting coloboma will be peripheral, no matter how we make the iridectomy, unless we drag on the iris, which we should of course never do. When the prolapse is free and large, it is necessary to avoid seizing the whole of it in the forceps grip if we would avoid making a complete iridectomy; it is not difficult to lay hold of just so much of it as lies near the disc, i.e., the peripheral portion only, and we shall thus attain the end we desire. If, however, the whole breadth of the iris has passed through the trephine hole, it is scarcely possible to avoid making a complete iridectomy, especially as we are then pressed for time, and must catch hold of the iris as best we can, before it slips back into the chamber.

We have spoken of the disadvantages of complete iridectomy in trephining, and we must now present its advantages. In cases into which any element of congestion enters, there can be no doubt that to remove a complete strip of iris, favors the free dilatation of the pupil, even if atropin is not instilled at the time of operation; but, what is still more important, it takes away the only obstacle to the free exhibition of this powerful mydriatic within the first few hours after trephining. No one, who has had an experience of the quiet iritis which so often follows operation for glaucoma by any and every method, can doubt the great value of the power thus put into our

hands by the performance of a complete iridectomy in congestive cases. So far as the simple non-congestive glaucomas are concerned, a peripheral iridectomy is all that is needed, and the advantages of leaving the sphincter intact have already been enumerated.

What are we to do if the iris re-enters the chamber before we can perform an iridectomy, or if it never prolapses from the start? The latter contingency arises (1) if a blunt trephine is used, which either effects an entry into the chamber at one spot only, or at least over too short a circumference to allow of the disc being raised up by the bulging iris; the fluid then drains gently off, the chamber empties, and the pressure behind the iris falls, so that the tendency to prolapse passes away; (2) if the iris is tied down by synechiæ to such an extent as to make prolapse impossible; and (3) if the pupil is widely dilated and rigid before the operation. In order to answer our question, we must consider the pros and cons of the case. In favor of performing an iridectomy, we have to remember that it saves the danger of a prolapse during convalescence, and the necessity, which then arises, of a second operation, always so unwelcome, especially in private work. Against the iridectomy are the following arguments: (1) in endeavoring to seize the iris we may damage the lens, the suspensory ligament or even the vitreous; (2) in the event of a sudden movement on the part of the patient, we may get iris tissue impacted in the wound; (3) experience shows that, provided a prolapse does not occur, we get quite as good a result without iridectomy as with it; and (4) the use of a miotic makes the risk of a secondary prolapse comparatively small. After very carefully weighing the risks on both sides, it is the author's opinion that if the iris fails to present (and in a properly carried out operation, this, in his experience, is seldom the case), it is better to leave well alone, and deal with any prolapse at a later stage, if necessary. The question resolves itself into one of deciding which is the lesser of two evils. In this connection it is always to be borne in mind that the narrowness of the trephine aperture markedly increases the danger of impaction and renders replacement of the membrane correspondingly more difficult, thus adding a possible and serious complication to the case and rendering the after-treatment more difficult. The method of performing an iridectomy is consequently of more importance in trephining than in most other operations. It is essential to put no traction on the iris, and to carry the scissor points right down into the wound whilst excising the portion of the membrane.

The toilette of the wound. It is most important that the iris should be thoroughly replaced, and that no uveal tags should be left in the

wound. If there is any doubt on this head we use the irrigator, and placing the nozzle at the entrance of the trephine hole, we direct a bold stream of saline solution into the chamber; this easily and quickly washes the iris back into place, always provided that it has not been dragged into the wound and impacted there at an earlier stage of the procedure. At the same time the chamber is washed free of any blood which may have been effused, thus giving us a clear view of details. The presence of a round central pupil affords proof that the iris has been thoroughly replaced. Sometimes when there is a little difficulty, we may attain our object by gentle massage with a spoon over the neighborhood of the wound, succeeded by another irrigation. If we are still unsuccessful, it is probably due to one of two very different conditions, viz., (1) impaction of the iris in the wound, as already mentioned, or (2) a return of intra-ocular tension, as the result of the free effusion of fluid into the posterior segment of the eye. The differential diagnosis is easy, for in the former case the eye can still be felt to be soft under the pressure of a spoon applied carefully over the cornea, whilst in the latter the almost stony hardness of the globe is very easily detected. To deal with the former case first: It is quite safe, and, in skilful hands, often not difficult to introduce a spud, with its tip bent forwards, into the trephine hole, and to clear the latter of iris. The use of the irrigator will complete the replacement still more satisfactorily, once the imprisoned iris has been loosened from its attachment to the sides of the tunnel in the sclero-cornea. On the other hand, when we are dealing with a hard eye, such manipulation as we have been describing should only be used with the greatest caution. If this rule is disobeyed, there will be considerable danger of damage being done to the deeper parts, for these are packed tight against the hole by the pressure of the fluid behind. The clinical aspect is best understood by reference to a phenomenon which may readily be observed by any surgeon who operates on late cases of glaucoma. Up to a certain stage all goes well. The trephine enters the chamber, the aqueous escapes freely, and the iris and lens move forward in the usual way; at this stage a spoon placed on the cornea shows that the eye is still soft, and yet in a very short space of time the globe is found to harden. We have felt this happen whilst the instrument was actually upon the eye, the tension passing from a condition in which the globe could be easily dimpled into hardness within a minute. At the same time, the outflow channel for the escape of aqueous has become blocked; fluid may actually be imprisoned in the anterior chamber, and yet it cannot find its way out, although a spud bent as above indicated can be seen to pass right into the chamber

in front of the iris, and in doing so to give vent to the imprisoned aqueous. The lesson is perfectly simple; a rapid effusion of fluid has taken place into the posterior chamber of the eye, either into the vitreous or between the coats of the globe. This has pushed forward the diaphragm of the eye (iris, lens capsule, lens and ciliary body) and by pressure of one or more of these deep structures has blocked the trephine hole. If the patient is placed in bed at once, the eye will, after a variable period, and often even after 24 hours, be found to be sub-normal in tension and to be filtering freely. The author holds most strongly that it is not in the interest of the patient to indulge in any manipulation once this hardening condition has manifested itself. He considers the patient should be put to bed with the least possible delay. It is true that he has at times been able to get a better replacement of the iris by a cautious use of the spud, but he doubts whether even this is justified. To wait, and to use miotics is, he thinks, sounder practice.

There remain to be considered two conditions which were not very uncommon in our earlier experience, but which we have not met with since we took to splitting the cornea, and thus placing our trephine hole farther forwards. In visiting a large number of hospitals in different parts of the world, the author has clearly seen that still, from time to time, surgeons, either through a want of appreciation of the importance of trephining far forwards, or through an inability to always carry out the necessary technique, make the mistake of placing the trephine hole too far back, either at or even behind the limbus. It seems, therefore, advisable to deal with the two possible complications above referred to, which may result from this mistake. They are (1) the effecting of an oblique or valve-like entry into the anterior chamber (vide Fig. 6), owing to the iris base being adherent to the cornea over a large area of the space covered by the trephine, and (2) the direct entry of the trephine into the posterior division of the aqueous chamber by reason of its cutting through the cornea and the adherent iris as one disc (Fig. 7). We are here dealing with cases in which the adhesions between the corneal and iridic surfaces have progressed so far forwards as to place a line of adherent tissue in front of the spot where the trephine has entered the chamber; we have tapped the posterior, and not the anterior division of the aqueous chamber. It is scarcely necessary to insist that the best way of dealing with these difficulties is to avoid them, as may be almost invariably done if the technique advocated herein is carried out. In the last 325 consecutive cases operated on in the latter part of the author's time in Madras, he found that it was always possible to effect a clean entry

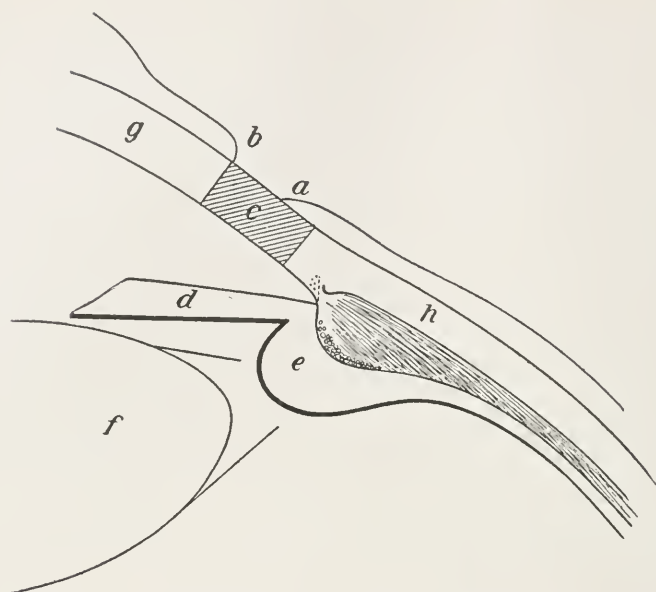


Fig. 4. Elliot's Operation. Shows Diagrammatically the Relation of Parts in a Case of Trephining in which the Iris Base Has Not Adhered to the Cornea.

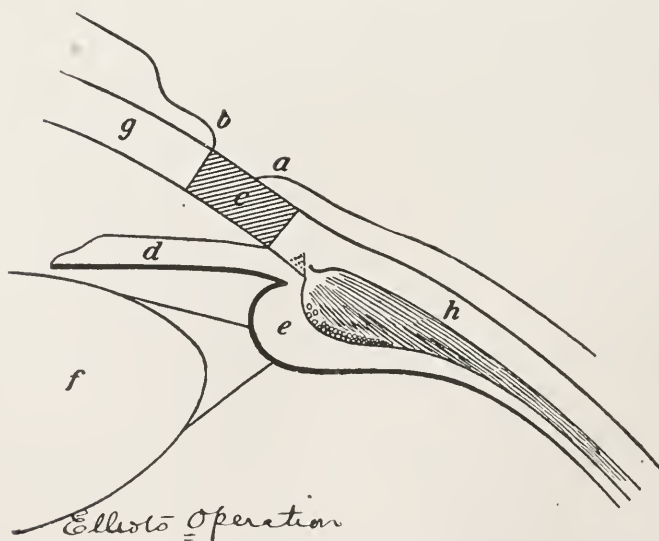


Fig. 5. Elliot's Operation. Shows Diagrammatically the Iris Base Adherent to Cornea; the Trephine Hole Lies just in Front of the Anterior Attachment of the Iris. The Danger of Iris Prolapse is Obvious.

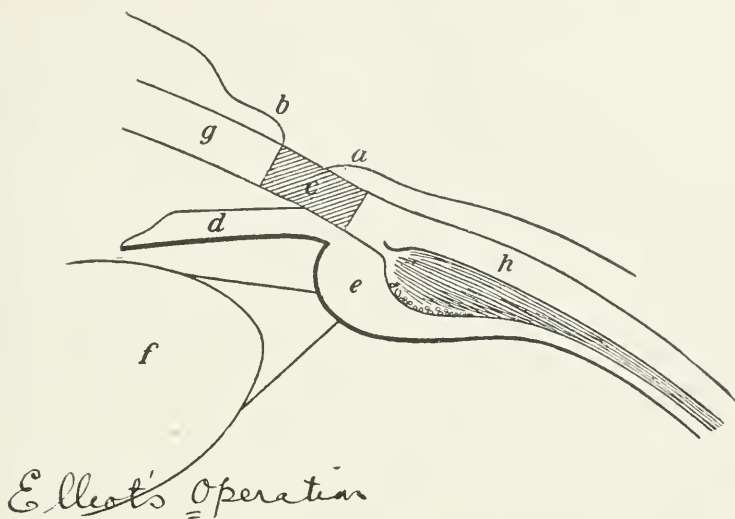


Fig. 6. Elliot's Operation. Shows Diagrammatically the Trephine Hole Entering the Chamber at the Anterior Part of Its Circumference, the Posterior Part Being Blocked by Adherent Iris.

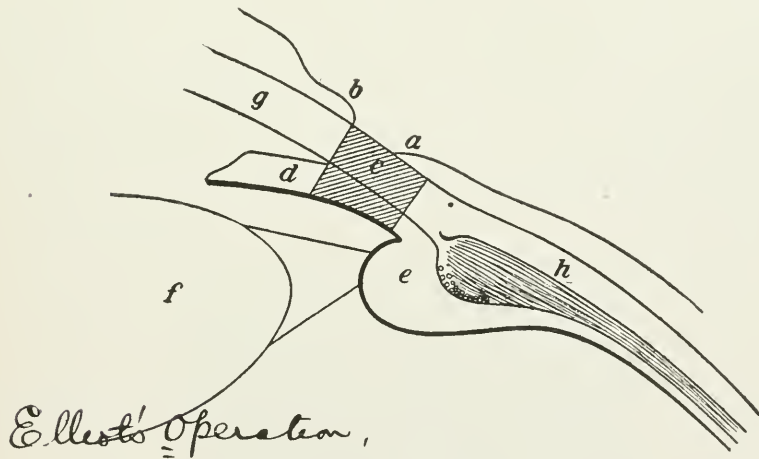


Fig. 7. Elliot's Operation. Shows Diagrammatically the Trephine Hole Passing Through the Cornea and the Subjacent Layer of Adherent Iris, in a Case in Which the Iris Is Adherent to the Cornea Far Forwards.

Figures 4 to 7 show diagrammatically the interference of iris with the trephine hole. *a*, Normal position of conjunctiva; *b*, conjunctiva reflected after dissection of the underlying cornea; *ab*, represents a section of the crescent seen on stripping the conjunctiva from the cornea; *c*, shaded, represents the piece removed by the trephine; *d*, iris; *e*, ciliary body; *f*, lens; *g*, cornea; *h*, sclera.

into the chamber, and to tap it directly thereby. In the 135 cases operated on in America, and in all those done in England, the same experience has held with very few exceptions. We shall not, therefore, discuss the treatment of a complication which should hardly ever be allowed to occur. Prevention, and not cure, is called for.

Having satisfied ourselves that the iris is well returned, we next replace the conjunctival flap in good position, by first laying it back over the raw surface from which it was dissected up, and then stroking it well into place with the aid of a spoon or of some similar rounded and blunt instrument. Two silk sutures will serve to keep the flap in place, and save the surgeon from any anxiety lest it should be rucked up by movements of the lids. In India, we rarely sewed up the wound; in Western practice, we find it expedient to do so, as a routine measure. It is sometimes a little difficult to get hold of the upper lip of the conjunctival incision; the way we have found best is to ask the assistant to raise the speculum off the eye, whilst at the same time exposing the upper fornix as far as possible in so doing; a pair of fine conjunctival forceps, passed up under the lid, then secures the edge of the wound without much trouble. An alternative procedure is to pass the two sutures through the upper lip of the incision when it is first made; it is then quite easy to do this. The ends of the sutures are kept out of the way on the sterile head towel during the operation, and to secure their asepticity, they are painted over with tincture of iodine just before they are used for the lower lip of the wound.

Theoretically, there are objections to the use of sutures in a wound which is kept for a long period in free communication with the interior of the eye by means of the aqueous fluid, which bathes it up to its very margin. Practically the risks have proved to be negligible, and the advantage of fixing the flap seems decidedly to outweigh them.

Finally, the upper lid is lifted off the eyeball and brought down to meet the lower one, the patient being at the same time told to look up and to close his eyes. Immediately before doing this, however, we gently stroke the cornea toward the trephine hole with a eurette, in order to ascertain whether the eyeball is still soft, and whether the escape of aqueous from the chamber is free.

Both eyes are then closed with aseptic pads and a bandage.

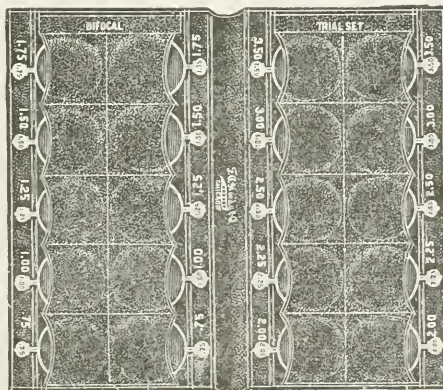
Instillation of drops. The adoption of iridectomy as a routine procedure has considerably modified our practice with regard to the use of mydriatics. If the case is one of simple, non-congestive glaucoma, and if only a peripheral iridectomy has been performed, we delay the instillation of atropin drops (gr. iv. ad ʒi.) until the dressing on the morning following operation. If the iridectomy has been complete,

and especially if the case is a congestive one, we instil the mydriatic drops before the patient leaves the table. The instillation should be repeated daily until all fear of quiet iritis is past. We have practically abandoned the use of miotics after trephining. We have formulated these rules because we find in congestive cases a strong tendency to the formation of posterior synechiæ. Moreover, even in non-congestive cases, we have to be constantly on our guard against this quiet iritis which gives so little evidence of its existence and yet is so dangerous to the preservation of sight.

In conclusion it may be permissible to repeat that the operation which the writer has practised, and which he has endeavored to introduce to the notice of the profession, is that of simple sclero-corneal trephining. The motive is to reach, tap, and sub-conjunctivally drain the anterior chamber, with a minimum of injury to the structures of the eyeball. To this end the junction of the cornea and sclera is trephined as far forwards as possible, the ciliary body is avoided, the chamber is entered directly by the trephine, and the iris is only dealt with in order to obviate any tendency it might otherwise have to block the trephine hole, and so to interfere with filtration. The cardinal rules are few and short, viz.,—(1) dissect the conjunctivo-corneal flap as far forwards as possible, splitting the cornea for the purpose; (2) utilize every fraction of a millimetre of the space so gained and apply the trephine as far forwards as possible, consistent with the avoidance of injury to the flap; and (3) use a sharp trephine. (R. H. Elliot.)

Triad, Hutchinson's. See p. 6068, Vol. VIII of this *Encyclopedia*.

Trial case. A case of lenses, prisms, frames, etc., for testing the refraction, accommodation, muscle balance, etc., of the eye. See p. 4727, Vol. VI of this *Encyclopedia*.



Bifocal trial sets have, it is claimed by some refractionists, become a necessary part of an office outfit. Such lenses instead of a combination of lenses has proven to be much better than any other form of testing. A few makers keep these sets (see the figure) in stock.

Trial frames. See **Test frames**, as well as p. 5284, Vol. VII, and p. 4731, Vol. VI of this *Encyclopedia*.

Trial-glasses. A graduated set of prisms and lenses used in vision testing.

Trial lens. A lens used in testing the refraction of the eye.

Trial sets. See **Trial case**.

Trial-sight. A term occasionally applied to the trial case of lenses employed to test the refraction, etc.

Triblet-tubes. Thin telescopic tubes, such as are used in optical instrument making.

Triboluminescence. Luminosity excited by friction.

Tribromomethane. See **Bromoform**, p. 1313, Vol. II of this *Encyclopedia*.

Trichia. (L.) An old term for entropion.

Trichiasis. This is a condition of the lid in which some or all of the cilia are distorted, displaced and turned inward toward the eyeball. Normally, the cilia are arranged in several rows on the anterior margin of the free border of the lid, those of the upper lid curving forward and upward, those of the lower lid projecting forward and downward. With partial closure of the eyelids there is a certain amount of interlacing of the eyelashes that furnishes a degree of protection to the eyeball from dust and wind.

In the milder forms of trichiasis, the posterior row of the cilia is turned backward, so that some or all of the hairs may come into contact with the eyeball. In the severer forms of the disease the anterior rows may also be directed downward or even backward, so that all of the lashes may rest against the eyeball. The cilia are usually changed in appearance, are stunted and stubby, and may grow straight out from the free border of the lid. Some of them may be so fine as to be scarcely visible to the unaided eye.

These changes are brought about by diseases or injuries that affect the border of the lid or the conjunctiva, and so alter the nature and direction of the hair follicles. Consequently we frequently see this condition after trachoma, blepharitis, burns of the edge of the lids and diphtheria; while the partial forms are noticed after hordeolum, chalazion and abscesses of the lids.

Trichiasis, aside from the disfigurement and discomfort that it produces, may be exceedingly serious, for the rubbing of the eyelashes

against the cornea may occasion pannus, as well as opacities or ulceration of that structure.—(W. H. W.)

Inasmuch as entropion is merely an exaggerated degree of trichiasis, the treatment (mostly operative) is practically the same for each. For this reason the various procedures in vogue at the date of the writing of the section on **Entropion**, p. 4331, Vol. VI, applicable for the relief or cure of trichiasis, are included and will be found under the former caption. See, also, **Cilia, Misplaced**, Vol. III, pp. 2216-2224, of this *Encyclopaedia*.

T. Harrison Butler's extensive experience at the British Ophthalmic Hospital in Jerusalem (*Ophthalmoscope*, p. 650, Nov., 1914) is of the greatest value in deciding *which form of treatment* is best adapted to certain varieties of this disease. He notes that trichiasis may be caused by entropion or by a growth of adventitious lashes in a false position, the so-called "distichiasis," or by a combination of both causes. It may be found at any age; in the East Butler had to operate upon children three years old. It may be present in any degree of severity. In severe cases all the lashes may sweep the globe, and in advanced trachoma the palpebral slit may be contracted by conjunctival atrophy and distortion of the tarsus until the eye is almost immobile. Fortunately, few European surgeons are called upon to treat such cases. In slight examples partial entropion may invert a few lashes, or there may be one or two adventitious cilia which touch the cornea.

Trichiasis may cause little or no trouble. The writer has often seen cases in which a whole row of cilia brushed the cornea without causing discomfort. On the other hand, one or two lashes impinging upon the cornea of a sensitive individual may cause intense pain. A complete secondary row of lashes may develop along the inner margin of the lid, and sweep the globe. These cases are difficult to treat by any splitting operation.

Trichiasis is caused by trachoma, by chronic blepharitis, and by spasm of the orbicularis. The last two causes are commonest in England.

The object of any operation undertaken to cure trichiasis must be, in the first place, to effect a permanent cure, and, in the second, to remedy the defect without producing lagophthalmos or any other deformity.

Trichiasis operations naturally fall into two groups: Those in which the tarsus is split from the edge; and those in which it is divided transversely. There is a third group of operations applicable only to trichiasis localized at the canthi.

Operations in which the tarsus is not attacked need not be considered, for in any but the most trivial cases they are quite ineffectual.

Butler says, "After performing over a thousand operations for trichiasis, I have found that the following methods meet all cases:—van Millingen's, Snellen's, a modified Spencer-Watson, and simple excision with a lip graft.

"The 'splitting operations' which I have tried are, the Jaesche-Arlt operation, a combination of Arlt's operation with Hotz's; Waldhauer's operation and van Millingen's operation.

"I have given the simple Jaesche-Arlt operation a very full trial, and have found it useful only in slight cases. In severe cases the tarsus is thickened, often to an enormous extent—I have seen it at least 3.5 mm. thick. There is much more cicatrization at its ocular than at its outer surface, and in consequence it is in tension, and has a constant tendency to spring inwards. This tendency is more marked on its inner aspect. When the lid is split, the inner lip contracts, and incurves; in consequence the outer lip, bearing the cilia, has no support, even when the skin has been shortened, and the cilia tend to drop inwards. A large gap is left which closes by cicatrization. This cicatrix contracts, and draws the lashes inwards again. For this reason these operations are often in severe cases a failure from the first, and, even if the first result be good, they soon relapse. I have known an apparently good case return in a month to be permanently cured by van Millingen's operation. In order to remedy this defect, I made the split more oblique, so as to detach completely the lash-bearing edge, I then stitched it down to the tarsus higher up in such a way that the lashes pointed rather upwards at first, thus combining the procedures of Arlt and Hotz. The results of this modification were good as regards permanent cure, but a large gap was left, and much thickening resulted from the healing process. J. W. Barrett, of Melbourne, has highly recommended this operation, and he stitches the inner lip to the lower lid for a day or two in order to keep the gap open for a longer time. After performing the operation a large number of times, I have abandoned it on account of its bad cosmetic effect."

The writer finds that in Waldhauer's modification of the Jaesche-Arlt operation, the split is made obliquely, so as to detach the lower edge of the outer lip of the split, and the piece of skin removed is left attached at its extremities and pushed down into the split. It is adjusted in place, and readily grows there. The first result is excellent. So good is it that he was at one time led into performing the operation a large number of times. But after a few months nearly all the cases returned. In all of them the hairs of the skin-graft had hypertrophied, and the artificial trichiasis thereby induced was as bad as the primary condition. In a few of the cases the skin-graft had become much

broader, pushing up the lashes and causing a very ridiculous effect. In all these cases Butler was obliged to cut out the skin and substitute a lip graft. It may be laid down as a rule, without exception, that skin may, in no case, be grafted into the lids internally to the lashes. It will always cause a secondary trichiasis.

Butler holds that van Millingen's remains the only satisfactory splitting operation. After performing it frequently, the writer believes that it is by far the best of all operations for trichiasis. It is especially indicated where there is conjunctival atrophy, where the tarsus is short, and in relapses from other operations, especially from Snellen's. It is perhaps rather a severe procedure in very slight cases, and it takes longer to perform than Snellen's method.

The operation is done in the following manner: The patient should be instructed not to epilate his lashes for a fortnight before. He should be anesthetized, and the cilia cut quite short from both upper and lower lid. The lids should be disinfected by being washed with warm water and soap, with alcohol, and with a solution of biniodide of mercury, 1-500. A Snellen's clamp is then inserted backwards, and the lid everted. A very much better clamp for the purpose could be constructed, but Snellen's suffices. The lid is carefully split from end-to-end of the clamp, the clamp removed, and the split continued upwards and inwards into the skin surface at each canthus. It may be carried 1 — 2 mm. into the skin, and deepened to 7 mm. It is essential that the split shall be long and deep, so that it loses its tendency to close, and gapes naturally. If the trichiasis extends to the canthi the split should be carried well into the skin at each end. Any vessel seen to be spouting should be twisted. The clamp is now inserted in its natural position, and a piece of skin removed from the lid, exactly as in the Arlt operation. Its breadth will depend upon the amount of loose skin in the lid. In many cases it is unnecessary to remove any at all. The skin wound is sewn up, and the clamp removed. As soon as the bleeding from the split tarsus has ceased, the inner lip of the wound should be carefully examined with a lens to detect hair follicles. Should any be found, they must be excised with scissors. If any roots are left behind, they will grow and appear between the inner lip and the graft, in a very undesirable position. The patient should be well under the anesthetic. A pad of wet wool is placed inside the lower lip, which is everted and compressed at each end between the fingers and thumbs of the assistant. With a sharp knife, a graft, 2.5 mm. broad and as long as the split, is marked out and detached with a pair of sharp scissors. While the assistant sews up the lip wound, the graft is spread on the back of the hand, and the submucous tissue removed with curved scis-

sors. If there is no bleeding from the wound, it is gently scraped, to provoke a little hemorrhage, and the graft adjusted in place. It should be gently pressed until the blood has coagulated under it. Should there be trichiasis at the canthi, the graft must be long enough to enter the skin. As soon as all hemorrhage has ceased, the graft is gently wiped clear of blood-clot, and the eye irrigated with boric lotion or normal saline. The lower lid must now be well greased with boric-vaseline, to prevent any possibility of the graft adhering to it. A piece of well-greased oil silk is used as a dressing, which should be removed after forty-eight hours. The greatest care must be taken that the graft does not adhere to the dressing, which should be taken away by the surgeon himself. The eye should be kept covered for four days, or the graft may become desiccated. If these precautions are followed, the graft will almost invariably adhere. If the lid be insufficiently split, the graft may be squeezed out of place. If at the first dressing it is found that this has happened, the split should be reopened and the graft reinserted again. It has a most extraordinary vitality, and this procedure is generally successful. After a very few days, the graft can hardly be distinguished from the conjunctiva. The only failure that is common is the appearance of one or two lashes internal to the graft. These lashes must be removed by two curved incisions, which include the lashes, and are deep enough to enable the root follicle to be excised. If the lid be tightly held in Grady's forceps, the operation is almost painless.

If it is decided to perform the operation on a case of distichiasis, where the lashes spring from the extreme inner margin of the lid (a very common state of things), the split must be made first in a transverse direction, and then parallel to the lid surface. In this case there will be several root follicles on the inner lip of the wound. These must be removed. van Millingen's operation is perhaps not best suited to these cases, but there is often so much atrophy that Snellen's operation would inevitably produce lagophthalmos.

The chief operations in which the tarsus is divided transversely are Snellen's, Panas', and Burow's.

Butler found that Panas' operation, although very efficient, causes much ugly thickening, and in cases where there is much atrophy, the lash-bearing fragment is liable to slough.

Burow's operation is liable to an early relapse. The tarsus is divided from the inside, and the contraction of the cicatricial tissue formed draws the lashes inwards.

Snellen's operation, as modified by Cant, has been performed in the British Ophthalmic Hospital, Jerusalem, considerably over ten thou-

sand times. In selected cases it gives an excellent result, and the cosmetic effect is almost always good. In fact, in the majority of cases, it is difficult to tell that an operation has been performed. In order that it may be successful, it is necessary that the tarsus be of good breadth, the operation must on no account be repeated, and there must be no conjunctival atrophy. If the trichiasis extends to the canthi, the operation must be combined with canthoplasties at either or both angles.

The objections to the operation are that a considerable number of the cases relapse, and if the tarsus be short, or the operation be repeated, lagophthalmos results. If there be much atrophy, the lower fragment may slough, wholly or partially. A canthoplasty does not seem to render sloughing more frequent.

Cant's modification of Snellen's operation is performed as follows.—Snellen's clamp is inserted, and the skin divided from one end of the clamp to the other, close to the lid margin. A second incision is carried through the skin at a height above the first which is gauged by the amount of loose skin in the lid. The piece of skin between the two incisions is removed. It is generally about 3.5 mm. broad. The skin is reflected upwards, cleansing the tarsus and removing the fibres of the orbicularis. The "cartilage" is now incised from one end of the clamp to the other, close to the roots of the cilia, and the incision is carried down to the conjunctiva. A second incision is made parallel to the first from one to two millimetres above it. This incision is also carried down to the conjunctiva. The narrow strip of tarsus included between the two incisions is now removed with scissors, leaving a long trough, the floor of which is formed by the conjunctiva.

The lower cilia-bearing fragment is now sutured to the tarsus above the trough, as in Hotz's operation, by four sutures. These sutures may or may not include the skin. When the sutures are tied after removing the clamp, the cilia will all be everted. In very slight cases, the piece of tarsus removed may be a mere shaving, or one incision may suffice.

The first incision must not be made too close to the roots of the lashes, or they may fall out and cause alopecia; on the other hand, the nearer the trough is made to the margin of the lid the better the eversion.

van Millingen's and Cant's operations are applicable to most cases of trichiasis. For slight cases Cant's is the better. It takes a shorter time, the cosmetic effect is certain, and it is a much less formidable operation. On the other hand, it weakens the tarsus and shortens it. The trachoma also tends to shorten the tarsus. In severe cases, or where the trachoma is still progressive, it should not be done. van Millingen's operation, on the contrary, lengthens the conjunctiva which is being shortened by the disease, it removes nothing, and so it can be ap-

number of people to compare the two hues. Most of them found the hues identical, but some, amongst whom were his three brothers-in-law, declared that they saw scarcely any resemblance; the pure color appeared yellow to them, while the compound color seemed to them nearly as red as sealing wax. To see the hues alike, these persons had to add so much green to the mixture that it appeared nearly pure green to a normal eye. The mixture of Lord Rayleigh was $3.13 R + 1.00 G$; that of his brother-in-law $1.5 R + 1.0 G$.

The persons in question presented no other anomalies of the chromatic system; they were by no means dichromatics (daltonists). Later researches (Donders, Koenig, and Dieterici) confirmed the opinion of Lord Rayleigh that these people formed a group by themselves: no intermediary forms have been found between their anomaly, and the normal chromatic system. The anomaly seems almost as frequent as dichromatism. No case is known in which the anomaly was discovered by the person himself who was affected."

Rochart, of Utrecht (*Klin. Monatsbl. f. Augenheilk.*, p. 539, 1914) states that a solution of iodine-green allows red, green, and blue rays to pass through. The transmitted red is regarded as non-chromatic. After the addition of sulphuric-acid the blue rays are absorbed; the new solution allows only a clear red and a clear green to pass. This solution exhibits the peculiarity, that with stronger concentration the red and green rays are not weakened in the same degree. It is therefore possible to find such a concentration by which the red and green rays appear white. If we fill two prisms with a solution, by shifting them about in this way we can produce this mixture of red and green. If the prisms are placed before a lantern they can in this way be used as an apparatus for color-investigation, especially for the unmasking of abnormal trichromasia. The person under investigation must indicate the position of the prism in which the transmitted light appears to him white. See also **Color-sense and color-blindness**.

Edridge-Green (*Proceedings of the Royal Society, B.*, Vol. 86, 1913), believes that: 1. Trichromic vision is not synonymous with anomalous trichromatism. 2. Many persons with otherwise normal color-perception make an anomalous equation. 3. Many color-blind persons (dichromics and trichromics) make an absolutely normal match with no greater mean deviation than the normal. 4. Color weakness is not characteristic of anomalous trichromatism, but of trichromic vision. 5. Anomalous trichromatism and color weakness are not synonymous. 6. A large mean deviation indicates color weakness. 7. Anomalous trichromatism appears to be due to an alteration in the normal relations of the response to the three colors (lights) used in the equation. If the

eye be more or less sensitive to one of the components of the mixed color whilst the other has its normal effect, an anomalous equation will result. An anomalous equation will also result when the yellow is more allied to green or red than is normal.

Trichromatic. TRICHROMIC. A person who sees three distinct colors in the spectrum—red, green, and violet. Such persons describe the region intermediate between red and green; that is to say, the orange and the yellow, as red-green, and blue as violet-green. It will be seen therefore, that their chief difficulty is distinguishing yellows and blues. A yellow, for instance, which is situated next to a green will be called red, and the same yellow when adjacent to a red will be called green. There are various degrees of trichromic vision, varying from those who are little better than dichromic to those who are tetrachromic. The trichromic rarely find any difficulty with their three main colors—red, green and violet.

Trichromic. See **Trichromatic.**

Triefauge. (G.) Blear-eye.

Trifacial neuralgia. TRIGEMINAL NEURALGIA. See **Neuralgia of the fifth nerve**, p. 8393, Vol. XII of this *Encyclopedia*.

Trifocal lens. A lens having three focuses or powers is sometimes desirable. A myope of high degree, who is also a presbyope, will find such a lens desirable, for such patients, as a rule, are not able to wear with comfort a lens that corrects their myopia in full, yet they often wish that they could see more distinctly than it is possible to with a lens that they can wear continuously. For instance, a patient having 16 D. of myopia, as a rule, will not be able to wear continuously with comfort more than 14 D., but would tolerate for a few minutes a full correction. Such a lens is produced by cementing a narrow — 2.00 D. scale to the top of their distance lenses. Such a scale made not more than 7 or 8 millimeters wide will not interfere with vision through the 14 D. as ordinarily worn, but by dropping the head a little, (so as to look through the upper part of their lenses) will insure the benefit of the full correction. If such a patient be also presbyopic a narrow + scale may be cemented to the bottom of the lenses, which will correct the presbyopia.

Emmetropes and hyperopes as well as myopes will sometimes find a trifocal lens useful. For instance, a watch-maker or a dealer in precious stones may wish a lens with three different powers, one for distant seeing, another for seeing at thirteen inches and still another for seeing at three inches or less. The latter lens is for magnifying purposes or for use as a loupe.

Such a lens is produced by cementing to the upper part of the outer

number of people to compare the two hues. Most of them found the hues identical, but some, amongst whom were his three brothers-in-law, declared that they saw scarcely any resemblance; the pure color appeared yellow to them, while the compound color seemed to them nearly as red as sealing wax. To see the hues alike, these persons had to add so much green to the mixture that it appeared nearly pure green to a normal eye. The mixture of Lord Rayleigh was $3.13 R + 1.00 G$; that of his brother-in-law $1.5 R + 1.0 G$.

The persons in question presented no other anomalies of the chromatic system; they were by no means dichromatics (daltonists). Later researches (Donders, Koenig, and Dieterici) confirmed the opinion of Lord Rayleigh that these people formed a group by themselves: no intermediary forms have been found between their anomaly, and the normal chromatic system. The anomaly seems almost as frequent as dichromatism. No case is known in which the anomaly was discovered by the person himself who was affected."

Rochart, of Utrecht (*Klin. Monatsbl. f. Augenheilk.*, p. 539, 1914) states that a solution of iodine-green allows red, green, and blue rays to pass through. The transmitted red is regarded as non-chromatic. After the addition of sulphuric-acid the blue rays are absorbed; the new solution allows only a clear red and a clear green to pass. This solution exhibits the peculiarity, that with stronger concentration the red and green rays are not weakened in the same degree. It is therefore possible to find such a concentration by which the red and green rays appear white. If we fill two prisms with a solution, by shifting them about in this way we can produce this mixture of red and green. If the prisms are placed before a lantern they can in this way be used as an apparatus for color-investigation, especially for the unmasking of abnormal trichromasia. The person under investigation must indicate the position of the prism in which the transmitted light appears to him white. See also **Color-sense and color-blindness**.

Edridge-Green (*Proceedings of the Royal Society, B.*, Vol. 86, 1913), believes that: 1. Trichromic vision is not synonymous with anomalous trichromatism. 2. Many persons with otherwise normal color-perception make an anomalous equation. 3. Many color-blind persons (dichromics and trichromics) make an absolutely normal match with no greater mean deviation than the normal. 4. Color weakness is not characteristic of anomalous trichromatism, but of trichromic vision. 5. Anomalous trichromatism and color weakness are not synonymous. 6. A large mean deviation indicates color weakness. 7. Anomalous trichromatism appears to be due to an alteration in the normal relations of the response to the three colors (lights) used in the equation. If the

eye be more or less sensitive to one of the components of the mixed color whilst the other has its normal effect, an anomalous equation will result. An anomalous equation will also result when the yellow is more allied to green or red than is normal.

Trichromatic. TRICHROMIC. A person who sees three distinct colors in the spectrum—red, green, and violet. Such persons describe the region intermediate between red and green; that is to say, the orange and the yellow, as red-green, and blue as violet-green. It will be seen therefore, that their chief difficulty is distinguishing yellows and blues. A yellow, for instance, which is situated next to a green will be called red, and the same yellow when adjacent to a red will be called green. There are various degrees of trichromic vision, varying from those who are little better than dichromic to those who are tetrachromic. The trichromic rarely find any difficulty with their three main colors—red, green and violet.

Trichromic. See **Trichromatic.**

Triefauge. (G.) Blear-eye.

Trifacial neuralgia. TRIGEMINAL NEURALGIA. See **Neuralgia of the fifth nerve**, p. 8393, Vol. XII of this *Encyclopedia*.

Trifocal lens. A lens having three focuses or powers is sometimes desirable. A myope of high degree, who is also a presbyope, will find such a lens desirable, for such patients, as a rule, are not able to wear with comfort a lens that corrects their myopia in full, yet they often wish that they could see more distinctly than it is possible to with a lens that they can wear continuously. For instance, a patient having 16 D. of myopia, as a rule, will not be able to wear continuously with comfort more than 14 D., but would tolerate for a few minutes a full correction. Such a lens is produced by cementing a narrow — 2.00 D. scale to the top of their distance lenses. Such a scale made not more than 7 or 8 millimeters wide will not interfere with vision through the 14 D. as ordinarily worn, but by dropping the head a little, (so as to look through the upper part of their lenses) will insure the benefit of the full correction. If such a patient be also presbyopic a narrow + scale may be cemented to the bottom of the lenses, which will correct the presbyopia.

Emmetropes and hyperopes as well as myopes will sometimes find a trifocal lens useful. For instance, a watch-maker or a dealer in precious stones may wish a lens with three different powers, one for distant seeing, another for seeing at thirteen inches and still another for seeing at three inches or less. The latter lens is for magnifying purposes or for use as a loupe.

Such a lens is produced by cementing to the upper part of the outer

end of the right or left lens (as desired) a small + 13 D. scale. When wishing to use the short focus lens the wearer tilts his head a little and is then looking through the + 13 D. lens, or whatever power he desires. The wearer of such a lens is able to examine anything while holding it close to his eye, thus obtaining a greatly enlarged retinal image, or what is the same thing, a magnified object. (*Hardy Messenger*.)

Triformal. See **Paraform**, p. 9256, Vol. XII of this *Encyclopedia*.

Trigeminal nerve, Ocular relations of the. See pp. 5193, 5194, Vol. VII, as well as p. 8393, Vol. XII of this *Encyclopedia*. See also, **Keratitis neuromyolytica**.

W. Uhthoff (*Klin. Monatsbl. f. Augenheilk.*, May, 1915) reports two cases of battle injury to the *trigeminus*. The first case was a man with a basal lesion of the fifth nerve caused by a splinter of a bomb. The wound of entrance was in the left temple. At first there was loss of consciousness. After he had recovered and the wound had healed, there was persistent irritability of the right eye, with pericorneal injection and recurring epithelial erosions in the lower part of the right cornea. As the injury had been a left-sided one, and there was no obvious cause for the condition of the right eye, he was suspected of deliberately producing the ocular irritation. He complained of a sense of pressure in the eye, but there seemed to be no pain. It was found, on investigation, that there was corneal insensibility, and loss of sensibility over the area of distribution of the first and second divisions of the fifth nerve on the right side. There was also diminution of the senses of smell and taste on the same side, and the right eye had lost the faculty of lachrymation, both reflex and emotional. An X-ray plate showed the presence of a splinter just in front of the Gasserian ganglion. At a later stage there was some disturbance of sensibility in the distribution of the third division of the fifth nerve. Uhthoff explains the corneal condition in this case as of a trophic character.

The second patient received a rifle shot in the left temporal region. There was a wound of entrance at the upper-outer margin of the orbit, and a wound of exit on the right side of the neck. He bled from the mouth and nose, and was for a time unconscious. There was found to be proptosis and blindness of the left eye, and some difficulty in swallowing. Seen four months later by Uhthoff, the left eye had only light perception in the outer field. There was no direct light reflex in the left eye, but the consensual was present. There were some blood streaks in the vitreous and changes in the fundus suggestive of severe concussion. There was paralysis of the second division of the fifth nerve on the left side. The missile had apparently passed down and in through the orbit, grazing the lower posterior part of the globe,

damaging the second division of the trigeminus, and then traversing the pharynx to the right side of the neck.

Trigeminal neuralgia. TRIFACIAL NEURALGIA. PROSOPALGIA. See p. 8393, Vol. XII of this *Encyclopaedia*.

Trigonocephalus. A triangular headed monster-fetus; a dolicephalic fetus with synostosis of portions of the frontal bone so that the front of the head is compressed.

Trihydric alcohol. See **Glycerine**.

Triiodomethane. See **Iodoform**.

Trikresol. This remedy is a mixture of ortho-, meta- and para-cresols from coal tar. It was first recommended by E. A. deSchweinitz in 1894 and later as an ideal antiseptic, although its use as eyewater causes a slight burning when first exhibited. Jackson employs it as a base for solutions of cocain, eserine, most of the mydriatics, and even boric solution in some cases; but not for solutions of homatropin or atropin, when repeated instillations are required, since even the slight sensations and increased lachrymation are objectionable. He has found that a solution of 1 to 1,000 is free from the risk of making the eye worse in any respect, that it is an antiseptic solution that will at least keep itself clean, and that it has a distinctly germicidal influence when used to wash out the conjunctiva. Although the solution of 1 to 1,000 has a very noticeable smell of trikresol, this does not remain about the patient on whom it has been used.

It seems superior to carbolic solutions to lay instruments in, to keep them from contamination after cleansing. It is also superior to formaldehyd solutions, for this purpose, because it is not necessary to rinse the instruments coming from it in something else before using them on the eye.

Trinitrophenol. See **Acid, Picric**.

Trinitrotoluene, Eye symptoms of. This is a highly explosive and poisonous compound obtained by nitrating toluene. It produces on workers in ammunition factories a form of intoxication characterized by dermatitis, gastritis, flatulence, vomiting, blood changes and (occasionally) ocular symptoms.

Livingston-Learmonth and Cunningham (*Lancet*, p. 261, 1916) in an article on the effects of the poison on women workers, divide the symptoms into two classes, irritative and toxic, and the latter again into digestive, circulatory, cerebral and special. Under cerebral symptoms they say: "Drowsiness is very common and many workers describe it as a sort of drugged feeling. Depression, lassitude and apathy are common. Transient loss of memory, *slight disorders of sight (blurred vision, etc.)*, and a certain amount of transient peripheral

neuritis have been noted in several of our cases. In severe cases delirium, coma and convulsions occur toward the end."

As terminal symptoms of *trinitrotoluene* poisoning, Rice (*Am. Journ. Pub. Health*, p. 273, 1917) mentions delirium, light-headedness and flighty utterances, followed by a stage of coma lasting about twelve hours and ending in death.

Alice Hamilton (*Monthly Review Labor Stat.*, May, 1917) reports that "The symptoms that follow inhalation of benzol and toluol fumes or absorption of these are, in mild cases as in severe ones, the symptoms of intoxication by a substance with a special action on the central nervous system: Dizziness, confusion, transient excitement followed quickly by stupor, twitching, then exhaustion, loss of consciousness, with respiration at first rapid then slow, pulse rapid, temperature low. Delirium, sometimes maniacal, is not rare; tetanic convulsions with marked opisthotonos and high temperature were described in one unusual case. Three cases developed meningitis before death."

Trional. This drug, resembling sulphonal and used as a hypnotic in doses of 10 to 30 grains (0.66-2. grm.), is a crystalline powder.

Triplet colors. A set of three fundamental colors that appear identical to the color-blind.

Triplet lens. A combination of three lenses, or lens systems.

Triplopia. The simultaneous formation of three visual images of an object.

Triplopia, Binocular. This is a term made use of by Javal to describe the condition that obtains in certain cases of squint. The patient may reach a period after operation when he fixes or localizes with reference to both the old and the new fovea.

Trippenartige Augenentzündung. (G.) Gonorrheal ophthalmia.

Triptocoria. That condition of the iris in which there are three distinct and separate pupils.

Tristichiasis. The name given first by Cornaz to a form of congenital distichiasis in which there are three rows of cilia.

Trisulcate. Three-grooved; three-furrowed.

Tritanope. A blue-blind person.

Tritanopia. TRITANOPSIA. Violet (or blue) blindness, indicating a defect in the *third* element necessary for color vision.

Triturations. In homeopathic pharmacology: to one part by weight of the drug add 9 parts by weight of milk-sugar crystals (lactose) and grind in a mortar which, with the pestle, is as clean as can be made with steam or by washing with water, rinsing with alcohol, drying at moderate heat and excluding all dust. In manufacturing pharmacies separate mortars are provided for the different drugs. The mortar

should not be made to grind more than one-tenth of what it will contain, else the trituration will be imperfect. The time allotted is determined by the nature of the drug. The Ix is triturated until its largest drug particles do not exceed $1/100$ inch in diameter—at least two hours. The drug strength of this is that of homeopathic tinctures (*Hom. Pharm. of U. S.*). The second decimal trituration, IIx, is made by adding 9 c.c. of sugar of milk to 1 c.c. of the Ix and triturating until the largest drug particles are not more than $1/2000$ " in diameter, except in case of drugs in which experiment has demonstrated the impossibility of thus producing such fineness. The largest particles of the third decimal trituration, IIIx, made in the same manner, do not exceed $1/4000$ " in diameter—with some few exceptions as above. The fourth and subsequent grades should each be ground as long as the IIx of the same drug had required. Triturations are commonly molded into 1 grain tablets for accuracy and ease in dispensing. See **Homoeopathy in ophthalmology.**—(J. L. M.)

Trivalene. BINITROTOLUENE. This poisonous explosive is the product of the second step in the nitration of toluene. When received as monotrinitrotoluene it is a heavy, dark-cherry-colored oil, and in the process of the second nitration it changes to a crystalline substance looking much like brown sugar. As such it has a faint odor of bitter almonds and a bitter, acrid taste.

Like monotrinitrotoluene it is absorbed through the skin and mucous membranes and when so absorbed seems to have a marked transient and perhaps more or less permanent effect on the central nervous system.

An account of the oculotoxic effects of the manufacture of this oily, explosive compound is given by A. S. Hamilton and C. E. Nixon (*Journ. Am. Med. Assocn.*, p. 2004, June 29, 1918). They report the case of a man who suffered from *optic atrophy as a result of the absorption of the poison*. J. B., aged 39, married, foreman in munitions factory, seen April 15, 1917, had one brother, five sisters and three children living and well. None were dead. The patient's father died at 63 of an accident. The mother died at 82 of old age. His general health had been good and he could recall no serious illness or injury. He had used very little tobacco and practically no liquor. There was no evidence of venereal disease, either by direct or indirect questioning. He had married at 35. He had worked in a munitions factory for two years, and before that as a fireman. In the factory his work had been with trivalene.

About one year before, one year after entering the plant, he first noticed numbness and prickling in the feet; in the course of five months this gradually spread to the knees. He had no pain, but described the

sensation as "like an electric tickling." At the end of the five months he was placed on outside work, and in the course of one month the numbness gradually grew less, but did not wholly disappear from the feet. After one month of other labor, he returned to his work in the trivalene plant as foreman, and in this position did not come quite so closely into contact with the trivalene as before. For five months there was no special change in his condition, but he still had the numbness in the feet. At the end of five months he returned to his former work of direct handling of the trivalene in the "sweat house." In one week the numbness had increased in the feet and legs. Directly after, early in December, his sight began to fail, objects appeared blurred, and he could not see well to read. His vision was then 20/40 in the right eye and 20/70 in the left eye. He was slightly cyanotic and appeared anemic. Shortly after, he noticed a little numbness in the tips of the fingers, and this had continued ever since but had not changed much. During the month of March his *eyesight* failed rapidly, and he quit work, April 5, 1917. At that time, vision was 20/200 in each eye. Since then his sight had failed further; April 8, vision was 6/200 in each eye. Later he could get about without difficulty, but he could not make out even the largest print and could not even make out the outline of a face. The left eye was a little worse than the right. There was no history of jaundice or gastritis and no loss of sexual, bladder or rectal control.

When asked to give the experiences of other men who worked with him, the patient stated that when foreman he had a crew of four men working under him; but as they habitually did not like the work or could not stand the fumes of the trivalene, they were constantly changing, and he was unable to describe the effect of the trivalene very accurately on them. One man worked for about six months handling the trivalene, and in that time developed a numbness and swelling of the feet so that he could not put on his shoes. He quit in the spring, worked on a farm all summer, and recovered, but did not return to the plant. "One man has worked in the trivalene for eight months with no apparent ill-effect. He takes no special precautions. Two or three other men who worked varying periods of time complained of numbness and tingling in their hands and feet and of difficulty in their gait, and headaches are frequent among the workers. All the men are provided with good leather gloves; but the trivalene, which is oily as they begin handling it and later turns to a crystalline substance, soon saturates their gloves so that they have little protection even over the hands."

All the cranial nerves were normal except as noted below. With the

right eye the patient counted fingers at 14 inches and with the left at 10 inches. The visual field was normal to rough tests except that there was some unusual dulling at the central point. The fundus showed a rather well developed atrophy with pale disk and some swelling of the veins and contraction of the arteries. The right pupil was somewhat larger than the left. The left reacted fairly and the right poorly to light, and both only fairly to distance. Both had had "drops" instilled some days previously. A watch was heard in the right ear at 18 inches and in the left at twelve inches. Air conduction was better than bone in both, and the Weber test was negative. There were no subjective sounds at the time of the examination, but the patient stated that at the time he quit work he had "rumbling sounds" in both ears. Vibration sense was lost in the toes but present in the malleoli and upward. Joint sensibility was distinctly impaired in the toes. Neither sense showed any impairment in the fingers. Pain (pin prick) was usually appreciated in the fingers and in the feet and toes, but touch (cotton) was impaired in both. Tendon and muscle pain sense were normal. There was no incontinence of urine or feces, and sexual power was not impaired. Sweating was evident in the hands and feet.

The muscles were of good volume and tone, but the patient insisted that his strength was much impaired and that his legs would often give way under him. In all the tests he gave very fair responses. He complained of stiffness and of an occasional pulling up or jerking of the feet and legs, especially at night, and said that this seemed like an "electric shock." Coordination was good in the upper extremities and impaired in the lower. The patellar and abdominal reflexes were present but diminished. The Achilles, biceps, triceps, supinator, jaw, pharyngeal, palate, plantar, anal, bulbocavernosus and cremasteric reflexes were normal. There was no patellar or ankle clonus. A blood test revealed: hemoglobin, 80 per cent.; red cells, 4,900,000; white cells, 8,000; differential count: polymorphonuclears, 73.5 per cent.; small mononuclears, 19.5 per cent.; large mononuclears, 5.5 per cent.; eosinophils, 0.5 per cent.; other forms, 1 per cent. The cerebrospinal fluid was clear with no undue pressure. The Wassermann, Nonne, and gold tests and cell count were negative. The Wassermann test was also negative in the blood.

Under treatment with laxatives and potassium iodid and sweating, the patient improved after about two months and has shown steady improvement since. In the month of February, 1918, he still complained of tingling and numbness in the toes. His vision was then 20/40 in the right eye and 20/60 in the left eye.

Trnka von Krzowitz, Wenzel. A Bohemian anatomist and surgeon, who devoted considerable attention to ophthalmology. Born Oct. 16, 1739, at Tabor, Bohemia, he received the medical degree in 1770 at Vienna. In the same year he was made professor of anatomy at the University of Tyrnau, in 1777 at Ofen, and in 1784 at Pest. He died at Pest May 12, 1791.

His chief ophthalmologic writing was "*Ophthalmia*" (1783).—(T. H. S.)

Trochia. An ancient term for the orbit.

Trochlea of the superior oblique. TROCHLEA OF THE ORBIT. The ligamentous ring or pulley attached by fibrous tissue to a depression beneath the internal angular process of the frontal bone, which transmits the tendon of the obliquus oculi superior. See p. 363, Vol. I as well as **Muscles, Ocular**, of this *Encyclopedia*.

Trochlearis. Obliquus superior muscle.

Trochlear nerve. The (fourth) nerve supplying the superior oblique muscle. See p. 5280, Vol. VII of this *Encyclopedia*.

Trockene Augenentzündung. (G.) Xerophthalmia.

Troeltsch, Anton Friedrich von. A celebrated German otologist, but only of moderate importance for ophthalmology. Born at Schwabach, near Nürnberg, Apr. 3, 1829, he studied at Würzburg, Vienna, Berlin, Prague, Dublin, London, and Paris. His medical degree was received in 1853. For a long time he taught otology in Würzburg, and practised both otology and ophthalmology. He died in 1890.—(T. H. S.)

Troja, Michele. A celebrated Neapolitan ophthalmologist. Born at Andria, Italy, he studied at Naples, became assistant surgeon to the Hospital of St. James of the Spaniards, and in 1774 removed to Paris. Here, almost immediately, he was appointed surgeon-in-chief and lecturer on ophthalmology to the Hospital for Incurables. He did not write much, but was highly esteemed both as an extractor and as a depressor of cataract. In 1781 he became surgeon-in-ordinary to the King and Queen. In 1812, after a visit with the King and Queen to Sicily, he returned to Naples. Here he was one of the founders of the Institution for the Education of the Blind, and here too he remained until his death, April 12, 1827.

His ophthalmologic writings are as follows: 1. *Nota sulla Can-nula Lagrimo-Nasale o Cannula di Dupuytren.* (Naples, 1780.) 2. *Lezioni Intorno alle Malattie degli Occhi.* (Naples, 1780.)—(T. H. S.)

Troma. A form of trauma.

Trommald, Edward Arbo. An ophthalmologist and oto-laryngologist of Los Angeles, California. Born near Christiania, Norway, son of Gunner Asleson and Kari Trommald, Apr. 9, 1865, he came with his parents to the United States in early boyhood, growing up in California. He received his medical degree at Stanford University, and studied the eye, ear, nose and throat at New York, Vienna and Berlin. For seventeen years he practised at Tacoma, Washington; for four years at Los Angeles.

Dr. Trommald was a tall, lean man, dark-haired, moustached, of fair-complexion,—and with light blue eyes. He was very quiet and retiring, fond of nature, study and travel. He was a member of the Lutheran Church.

Dr. Trommald married on Sept. 23, 1903, Miss Bessie B. Blackburn. Of the union was born a son, Edward Theodore.

The doctor died, after an operation for appendicitis, at his home on Signal Hill, in Long Beach, Feb. 17, 1918.—(T. H. S.)

Tropacocain. BENZOYL-PSEUDOTROPIN. This alkaloid occurs as colorless crystals and is found in the leaves of erythroxylon coea, the Java coca plant. It differs chemically from cocain and has decided mydriatic powers.

The hydrochloride is generally prescribed. It is best combined with 0.6 per cent. sodic chloride in 1 to 4 per cent. solution. It is cheaper, more stable and more easily sterilized than cocain, while its anesthesia occurs more rapidly and lasts longer. On the other hand, it is quite poisonous and not more than half a grain (gm. 0.03) should, on that account, be used for injection anesthesia.

Tropein. Any ester of tropin; a compound of tropin with an organic acid. The natural mydriatic alkaloids are tropeins.

Trophic keratitis. See **Band-shaped keratitis.**

Trophic nerves. The "trophic" theory was advanced in 1824 by Magendie that neuroparalytic keratitis (*q.v.*) and similar affections are due to the abolition or inhibition of special (trophic) nerve-fibers running in the nutritive nerve supply.

Trophoneurosis. A neurosis dependent on nutritive changes.

Tropical eye diseases. See, in particular, **Filaria; Race; Ethnology; Trypanosomiasis; Sunlight, Tropical and Light.** A. Leber (Göttingen) has written rather extensively on this subject, his report having been based on observations on a journey to the South Sea and Dutch India.

Tropical sunlight. See **Sunlight, Tropical.**

Tropidin. An oily, liquid base with an odor like coniin, obtained by dehydrating tropin.

Tropin. A crystalline substance with a tobacco-like smell and doubtful action on the pupil derived from atropin and from various plants.

Tropococain. See **Tropacocain**.

Tropometer. This valuable instrument is fully described and illustrated on p. 1415, Vol. II; on p. 4697, Vol. VII and under **Muscles, Ocular**, p. 7984, Vol. X, of this *Encyclopaedia*.

Wendell Reber (*Journ. Am. Med. Assocn.*, p. 1082, Sept. 21, 1912) reported the findings of the instrument in 100 normal eyes and demonstrated its merits in dealing with strabismus and other oculomuscular anomalies.

Troughton, John. A famous blind Puritan minister. He was born at Coventry, England, in 1637, the son of a clothier. At the age of 4 he was totally blinded by small-pox. When 19 years of age he entered as a scholar at St. John's College, Oxford. Here he received the Bachelor's degree and became a Fellow. At the time of the Restoration, he (being a Puritan) lost, as a matter of course, his fellowship. He then gave private instruction for a number of years in Bicester. After the "Declaration for Religious Toleration" (issued in 1671) he returned to Oxford and began to preach at a private house in Thames Street. He seems to have been a remarkably eloquent speaker, as well as a man of zeal and erudition. He was also a well known writer. Among his works are: "*Lutherus Redivivus, or The Protestant Doctrine of Justification by Faith Only*;" "*Letter to a Friend Touching God's Providence*;" "*Papery the Grand Apostasy*;" "*An Apology for Nonconformists*."

Troughton died at Oxford, Aug. 20, 1681, aged 44. His funeral sermon was preached by one of his blind friends, and he was buried in the church at Bicester.—(T. H. S.)

Trou optique. (F.) Optic foramen.

Trou orbitaire supérieur. (F.) Supra-orbital foramen.

Trousse. (G.) Combination set.

Trow, Charles. A well known Canadian ophthalmologist. He graduated at Trinity Medical College, Toronto, Canada, and practised in that city. He became associate professor of ophthalmology and otology at the University of Toronto and a member of the Medical Council. He died Oct. 8, 1911, aged 55.—(T. H. S.)

Troxler's phenomenon. Tscherning (*Physiologic Optics*, p. 285) describes this experiment as follows: If we draw several black spots on a sheet of paper and fix one of them for some time, we see sometimes one, sometimes another of the surrounding spots disappear, to

reappear a little while after, generally at the moment of winking or of making a slight movement of the eye. This singular phenomenon which was described at the beginning of the nineteenth century by Troxler, has recently been studied by Holth. The color of the background, as well as that of the spots, plays no part; during the disappearance of these latter we see in their place the background only; the scotoma is, therefore, filled almost like the spot of Mariotte. Even the spot fixed may disappear after a long period of fixation.

Trübung. (G.) Cloudiness.

True cataract. Lenticular cataract.

Trump, Jacob F. A well-known ophthalmologist and oto-laryngologist, of Hamilton, Ohio. He was born in Pennsylvania in 1851. He was twice married: first, to Mary Framton, and, after her death, to Mary Wilson, in 1891. He received the degree of doctor in medicine at the University of Vermont in 1881. He was a very successful specialist, and a good, all-round operator. He died at Hamilton, Ohio, in Dec., 1914.

Dr. Trump was a small, stout man, of dark complexion and gray eyes, who always wore a small mustache, and whose manner was quiet and reserved to a fault. Always courteous and obliging, he was nevertheless practically unknown, even to the members of his own profession. He was a member of the Presbyterian Church, and, in his own quiet way, active in charitable enterprises.—(T. H. S.)

Truncated cones of Kolbe. A device used for the detection of color-blindness. See p. 5092, Vol. VII of this *Encyclopaedia*.

Trypanosoma equiperdum. A sporozoan parasite (also called *T. rougeti*) found in a disease of horses. It is prevalent in Algeria where it is locally known as *dourine*. See **Trypanosome keratitis**.

Trypanosomiasis. SLEEPING-SICKNESS. This is a tropical disease affecting both man and animals. In the Congo region it is due to the bite of the fly *Glossina palpalis*, host of the *Trypanosoma gambiense*. The early (fever) stage of the disease is ushered in by chills, rise of temperature, vomiting and headache. Alternations of pyrexia and chills may last for months. Later—perhaps not for months or even years—the central nervous system is involved (depression, lassitude and somnolence) when a fatal outcome is only a matter of time. It sometimes happens that the vision is involved. See **Sleeping sickness**.

C. W. Daniels (*Ophthalmoscope*, December, 1915), writes of the importance of the eye lesions as one of the diagnostic signs of trypanosome infection. The eye lesions vary and are not alone diagnostic, but in some cases are the first to cause the patient to seek medical opinion. The eye lesions are essentially a *toxic iridocyclitis with a*

varying amount of keratitis, circum-corneal congestion, conjunctivitis and photophobia of varying degree.

Thirty-two cases are tabulated by the writer according to the part of Africa where the disease was acquired. Eye lesions were present in six Rhodensian cases, 83.3 per cent.; in ten Nigerian cases, 40 per cent., and in cases from other parts of tropical Africa, 18.7 per cent. Eye lesions were present in 37.5 per cent. of all cases.

The same writer (*Br. Journ. of Ophthalm.*, p. 83, 1918) later published a list of 44 cases of trypanosome infection occurring in men, which were seen by himself. Of these, 35.7 per cent. had eye lesions. Daniels considers the eye lesions a manifestation of a toxic cause.

Trypanosome keratitis. Warrington Yorke (*Med. Press*, May 15, 1912; abstract in *Ophthalmology*, p. 206, Jan., 1913) calls attention to the resemblance which syphilis bears to sleeping-sickness in many important respects; both are the result of protozoal infection and clinically present many points in common, including affections of the eye.

Three goats and a horse inoculated subcutaneously with a strain of trypanosomes derived from a case of sleeping-sickness all developed interstitial keratitis which was remarkable in being transient. The corneæ of these animals showed upon microscopical examination marked thickening of the substantia propria, a scattering of edematous patches, marked cellular infiltration, large numbers of trypanosomes and considerable vascular formation. The rapidity with which these processes occurred in the cornea was very remarkable.

Although the *Treponema pallidum* has yet to be demonstrated in the corneæ of patients suffering from syphilitic interstitial keratitis, there is a considerable amount of evidence in support of the view that this condition results from the presence of spirochætes in the substance of the cornea. The writer refers to experiments in which the eyes of apes were inoculated with syphilitic material and in which the multiplication of the spirocheta pallida in the substance of the cornea was seen; to the production of keratitis in the eyes of rabbits and dogs by injecting small particles of a human chancre into the anterior chamber; and to Stephenson's demonstration of spirochætes in the apparently normal eyes of syphilitic fetuses and babies.

Yorke says that it would appear that the spirochætes may lie dormant in the cornea and other parts of the eye for many years. They cause no mischief until some determining factor, of a local or general nature, lowers the resistance of the tissue, and allows the parasite to get the upper hand, when an attack of interstitial keratitis results.

He emphasizes his opinion that these lesions in protozoal infections result from the local multiplication of the specific parasite, and are not merely trophic or toxic manifestations of the disease.

The experimental studies of deSchweinitz and Woods (*Trans. Am. Oph. Soc.*, p. 107, Vol. 15, 1918; abs. *Ophth. Lit.*) were carried out on dogs, using the *T. equiperdum*. The organisms were injected intraperitoneally with the blood of white rats infected with such trypanosomes. To infect the dogs, 1 cc. per kilo of body weight of the blood was used. General symptoms appeared after a period of one to two weeks, dogs becoming drowsy and listless, sleeping constantly, localized swelling due to edema appearing over the body. Invasion of the trypanosomes appeared in every fluid of the organism.

The period of incubation was variable. Ocular symptoms appeared between two and eighteen days after the trypanosomes were found in the blood. There were noted two types of ocular lesions. First, simple clouding of the cornea. Second, a severe form with exudations and hemorrhages in the anterior chamber, the cornea becoming opaque. Trypanosomes were found in the aqueous of all eyes showing lesions.

From their experiments the authors concluded that the ocular lesions were not due to a general toxic condition. The development of corneal symptoms were synchronous with the appearance of the organisms in the aqueous. It was shown that anemia bore no relationship to the ocular lesions.

The authors concluded from their experiments that there is an actual invasion of the tissue by the parasite. *Pathologically the corneal lesions are those of an interstitial keratitis.* There was a prompt improvement, if not complete cure, by the proper use of arsenobenzol.

Uveitis as a result of trypanosomiasis. Morax (*Annales d'Oculistique*, p. 343, July, 1908) records a case in which an attack of *iritis*, and later in the same eye an attack of *cyclitis*, occurred in a physician a few months after his infection by the trypanosoma gambiense, in spite of treatment by atoxyl. Recovery was complete, with full vision. Morax also brings together the previously reported cases of trypanosomiasis in human beings, involving the eye, making 6 in all. Iritis occurred in 4 cases. In one there were spots of choroidal atrophy and pigmentation, and in one the account refers only to temporary impairment of sight. The ocular lesions seen in the lower animals have been more thoroughly studied. They include blepharo-conjunctivitis and corneal inflammations, parenchymatous and ulcerative. Potocky reports from histologic examination of the tissues, that the ocular

affection is a subacute inflammation, with infiltration of round cells and cell-proliferation. Clouding of the cornea he finds in part due to edema, and in part to round-cell infiltration.

J. W. H. Jellett (*Ophth. Review*, February, 1915), reports a case for the reason that the connection between trypanosomiasis and *iridocyclitis* does not appear to have received full recognition from ophthalmologists, although the causal relationship between the two is believed well-known to experts in tropical medicine.

After a sojourn in Northern Nigeria the patient returned suffering from recurrent attacks of "fever" and a tapeworm. The attacks of fever remained after being rid of the tapeworm. Shortly after return to Nigeria, ocular symptoms began to develop and were recurrent. Prolonged search discovered trypanosomes in the blood, and patient was sent to a school of tropical medicine for atoxyl treatment.

All other possible sources of toxin poisoning, including syphilis, were carefully eliminated. With the exception of one carious tooth, which was immediately extracted, the buccal cavity was in good condition, as was the remainder of the alimentary tract. The accessory sinuses showed no signs of disease, either clinically or on transillumination, while the heart, lungs, and other internal organs were perfectly healthy. It is, therefore, difficult to come to any conclusion other than that the iridocyclitis was due to the trypanosome infection.

American trypanosomiasis. Tejera (*Gaceta Médica de Caracas*, p. 26, May 31, 1919; abs. *Journ. Am. Med. Assocn.*, Aug. 16, 1919) presents conclusive evidence that the trypanosome thyroiditis described by Chagas in 1907 as common in children in certain parts of Brazil prevails also in Venezuela. He reports two cases, in an infant and a boy of 2, belonging to the states of Trujillo and Zulia. His extensive study of the subject has demonstrated further that it is transmitted by a different insect from the one responsible for it in Brazil, *Lamus* (*Conorhinos*) *megistus*, as this does not seem to occur in Venezuela. The bug responsible for the transmission in Venezuela is *Rhodnius prolixus* Stal, as he determined by extensive experimental research and these clinical experiences. These insects in nature may harbor *Trypanosoma cruzi*. The insects are called by various names, pito, chupon, quipito, chinche de monte and chipo. It is a night-biting insect of the reduviidæ family. Some specimens sent to Paris in 1913 from Venezuela were artificially infected by feeding them with *Trypanosoma cruzi* sent from Bahia, Brazil. Rincones presented Tejera's report sent from the laboratory of the Caribbean Petroleum Company at Mene Grande, and he added that a few years ago he urged research in Venezuela to find whether this American trypanosomiasis was

restricted to Brazil alone. Tejera mentions in conclusion that as goiter seems to be endemic in the Santander district in Columbia, Chagas' disease probably could be discovered there also. He was examining the rhodnius or Leishman bodies, in a study of American Leishmaniosis, when he was surprised by the discovery in them of *Trypanosoma cruzi* of Chagas' disease. But his clinical cases of the latter came from a different district, and he found the trypanosome likewise in specimens of rhodnius from the environment of the patients. Rats, cats, monkeys and other animals inoculated from the insects developed the trypanosomes in large numbers in the blood. Ayala added that Tejera's research seems to exculpate the drinking water in respect to endemic goiter. He appealed further for research to decide whether there may not be some plant which serves as a host for the trypanosome like the euphorbia for the leptomonas (Iturbe), suggesting some zoological affinity between plants, Leishman bodies and trypanosomes.

Trypan-red. A brown powder soluble in water. It is used by injection to destroy trypanosomes or for conferring immunity against them. It has also been used in carcinoma and lymphadenitis. Its employment in ophthalmology has so far been limited to experimentation on the lower animals. Paul A. Lewis (*Journ. Exp. Medicine*, p. 669, May 1, 1916) has studied its distribution to the tissues and vessels of the eye as influenced by congestion and early inflammation. All the observations have been made on the rabbit's eye. The azo-dye trypan-red as furnished by Brübler has been the substance chiefly employed for testing the permeability. This dye has been dissolved in normal saline solution to the amount of one-quarter of 1 per cent. 100 cc. of this solution may be warmed to body temperature and injected slowly into a full grown rabbit by the intravenous method without causing the animal any immediate distress and with no appreciable evidence of toxicity later. Under these circumstances by the time the injection is finished the skin and mucous membranes of the entire body are stained red. The intensity of the stain in the tissues increases for a number of hours to a maximum which is maintained without appreciable change for a number of days, and which then gradually fades out over a period of weeks and months. Trypan-blue and other azo-dyes of similar physiological activity may be used in the same general way.

Trypan-red is a colloidal substance; that is, its watery solutions do not diffuse through parchment paper. When, therefore, the dye leaves the blood vessels to appear in the tissues, the lymphatic spaces, lachrymal secretions, or the urine, its passage is in itself evidence

that the interposed tissue surfaces are not perfect dialyzing membranes. They are either leaky mechanically to substances of certain physical constitution, or they exert a selective action which permits some colloids to pass while retaining others.

If the normal eyes are observed at any time after the injection of the dye in the manner described it will be seen that the sclera shares the stain of the skin with greater or less intensity. No stain can be detected in the cornea or anterior chamber fluid by inspection of the eye. If, however, after a number of hours the aqueous humor be withdrawn it will be found to have a barely appreciable pink color. If at the end of a week or 10 days the animal is killed, the eye removed, and the cornea dissected free, it also will be seen to be stained very faintly although definitely. If the blood be withdrawn immediately after the injection, the serum is found intensely stained with the dye. As the tissue stain increases in intensity, the stain disappears gradually from the blood to a minimum point which is probably long maintained.

Observations of trypan-red on the aqueous humor. If within a few minutes after finishing the intravenous injection one eye is cocaineized and the anterior chamber fluid withdrawn, a colorless fluid is obtained. As the chamber refills, which it does in the course of a short time, the reformed fluid is stained intensely. The rapidity with which a stained fluid appears in the anterior chamber following such a tap varies considerably in different rabbits. It is also possible so to alter the physiological condition of the eye that the dye when injected intravenously will quickly appear in the anterior chamber without the preliminary tapping.

In a preceding paragraph it was said that a number of days after an intravenous injection of trypan-red the cornea becomes distinctly colored. It is the generally accepted view that substances which reach the cornea do so by diffusion from the corneoscleral margin. The way in which the cornea becomes stained is in accord with this. If an animal is killed 2 or 3 days after the dye is injected, the cornea will, on examination, be found stained at its circumference, the colored area at this time reaching about one-third of the way to the center.

"In connection with the study of experimental tuberculosis previously referred to, we observed that the reactions of the cornea were not uniform throughout. If, for example, a central inoculation is made, the first formation of blood vessels at the corneoscleral margin will be above, at approximately the midline. Next, vessels will form on the midline below, and, lastly, on the sides. This was probably

because substances diffused out of the cornea by preference toward the upper portion and hence stimulated the tissue reactions first at that point. That the diffusion is along these lines we have now found can be shown to be the case with the dyes we have used in this work. If the cornea is infiltrated in a spot 2 to 3 mm. in diameter at its center, the dye does not diffuse toward the lower corneoscleral margin in any appreciable degree. The diffusion is chiefly toward the upper margin, spreading out more or less in the shape of a fan in this direction. To get a diffusion chiefly toward the sides or lower margin it is necessary to place the infiltration quite close to the corneoscleral junction in those directions."

Trypsin. See **Pancreatine**, p. 9221, Vol. XII of this *Encyclopedia*.

Tscharaka. An ancient East Indian physician of some ophthalmologic importance. See **Charaka**.—(T. H. S.)

Tsetse fly. The local name for the host of the parasite that produces sleeping-sickness (*q. v.*).

T-shaped sclerotomy. See under **Glaucoma**, p. 5551, Vol. VII of this *Encyclopedia*.

Van Lint (*Ophthalmology*, April, 1914) has slightly modified the original operation as follows: Starting from the horizontal meridian of the cornea, he dissects the conjunctiva all around the upper half of the cornea. He makes the dissection deeply, in order that the conjunctival flap may be as thick as possible, and that the sclerotic may be well exposed. The dissection ought to be made broadly, and should reach fully a centimeter from the corneal limbus. He then inserts two threads of silk of medium thickness, one on each side of the cornea. In placing the inferior extremity of the threads, he introduces the needle beneath the conjunctiva, in the horizontal meridian of the cornea, near the limbus, to penetrate the conjunctiva 2 mm. lower. The needle which carries the superior extremity of the thread he enters beneath the detached conjunctival flap about 10 mm. from the place of introduction of the inferior extremity of the thread.

Van Lint next introduces the blade into the sclerotic in the same manner as in antiglaucomatous iridectomy with this difference that he places the section at 2 mm. or 2.5 mm. from the limbus instead of making it 1 mm. or 1.5 mm. In consequence of the posterior situation of this section, the point of the knife, instead of passing in front of the iris, generally transfixes it and produces an iridodialysis.

Sometimes he is content with the iridodialysis, sometimes he makes a partial peripheral iridectomy; sometimes a complete iridectomy. He remarks in this connection, "I consider that in the acute or sub-acute forms of glaucoma one should make a complete iridectomy, and

not be contented with peripheral iridectomy or iridodialysis, as in the chronic forms. In a word, the interference with the iris ought to be the more considerable as the form of glaucoma is more acute. As the iris is often united to the cornea, and as the wound is more posterior than in the ordinary iridectomy, I often introduce the forceps behind the iris. Under these conditions, it is difficult to seize the iris with the forceps constructed with mouse-teeth directed from the side of the convexity. It is then preferable to use a forceps of which the tooth between arms of the forceps is directed toward the concavity."

He now introduces one of the branches of a pair of straight, slender scissors, into the scleral wound at its middle, and pushes it sufficiently far toward the anterior chamber for the sclerocorneal section, made at one cut through the corneal tissue 1 mm. to 1.5 mm. from the limbus. The result is that the radiating section which starts from the middle of the scleral section concentric with the limbus, forms the vertical branch of T and measures from 3 to 4 mm.

While an assistant with a forceps takes hold of the middle of the conjunctival flap and draws it over the sclerocorneal wound, which it ought to cover, he ties the threads inserted at the beginning of the operation and then cuts them close to the knots. A bandage is kept over the eye during several days and pilocarpin instilled three times a day for several weeks. The threads are removed on the fourth or fifth day. The conjunctival flap which covers the cornea, retracts by degrees, and resumes its original situation at the end of a week.

Tubercle. See **Tuberculosis of the eye.**

Tubercular (more properly *tuberculous*) **diseases of the eye.** See **Tuberculosis of the eye.**

Tuberculin. TUBERCULIN TESTS. TUBERCULIN THERAPY. The employment of this valuable agent, *both in the diagnosis and treatment of eye diseases*, is extremely important to the ophthalmologist. Hence the following extended account of the chemistry, mode of preparation, methods of administration and dosage of the various kinds of tuberculin and their substitutes as we find them in the market. It should be added to the following account (see Wood's *System of Ophthalmic Therapeutics*, p. 129; and the *Extra Pharmacopeia*) that there are several tuberculin preparations made outside of Germany (in America, for instance), carefully manufactured and quite as reliable as the Koch products. These tuberculins and their congeners are, however, practically identical with the German preparations and a description of the one will amply suffice for the others.

Tuberculin, Old. Tuberculinum Kochii, P. G. *TA*. This is an amber-colored liquid, an old, glycerine, broth culture of the tubercle bacillus of the human type boiled and concentrated, from which the bacilli have been removed by filtering. It is supplied in 1 cc. bottles and is used (a) in diagnosis of tuberculosis, and (b) as an injection for the cure of disease due to the tubercle bacillus. It is employed (a) To diagnose human tuberculosis. The temperature must not exceed 98.6° F. at the time of the injection. Dose.—One-thousandth of a cubic centimetre (0.001 cc.) diluted to 1 cc. (termed “No. 3 dilution”), or if patient is weakly, or a child, use 1-10,000 cc.; (0.0001 cc.) in 1 cc. fluid (called a “No. 4 dilution”). If there is no rise in temperature after the first injection, inject a double dose on the next day but one following. If the first injection causes even ½° F. rise, wait until the normal temperature is reached and again inject the same dose. If the reaction is now more violent than after the first injection tuberculosis is undoubtedly present. If no reaction appears after the first small dose, the dose may be increased to 5 cc. of tuberculin No. 3 and, finally, to 1 cc. tuberculin dilution No. 2, i. e., 1-100 cc. of the strong liquor. If there is no reaction on twice repeating the latter dose one may conclude that no recent or progressive tuberculosis exists.

New-tuberculin Koch. This bacilli emulsion is a suspension of pulverized tubercle bacilli in water with an addition of an equal volume of glycerin. 1 cc. contains 0.005 gm. of powdered tubercle bacilli. Dose—1-2000 cc. (= 0.0000025 gm. of bacillary substance) as a rule to begin with. Dilutions are made with 0.8 per cent. sodium chloride solution, or if the dilutions are to be kept several days with 0.8 per cent. sodium chloride and 0.5 per cent. phenol.

With this small dose it is very exceptional for any reaction to appear. At one or two days intervals the dose is rapidly increased from twice to five times the dose at each injection until definite reaction appears with a rise of 2½° to 5° F. in temperature. As soon as such violent reaction develops much longer pauses, 6—8 days, must be made. If, however, it is desired to carry out the treatment without violent reactions, the dose must be increased at a rate which only causes little or no rise in temperature, and between each injection 5 to 7 days' intervals should be allowed. Otherwise the same procedure is followed.

The subcutaneous injections are increased until the dose reaches 20 milligrammes. Larger quantities are badly absorbed. If absorption takes place too slowly, it is advisable to inject the dose at two or

more points. The larger doses of 10 to 20 milligrammes are only injected at intervals of 2 to 4 weeks.

Bovine tubercle bacilli emulsion corresponds in every respect to New-tuberculin Koch-bacilli-emulsion just mentioned except that instead tubercle bacilli of the bovine type are used. Its method of application is like the last mentioned.

A number of other tuberculin preparations (indicated often by initials) have been put on the market. Among them are the following:

TAF = albumose-free tuberculin, used for cutaneous test. TBE, the same as the original Koch preparation. TO = *tuberculin obere* or upper tuberculin, soluble in glycerin. TF = tuberculin filtrate. BF = bouillon filtrate, or bouillon cultures of tubercle bacilli. TR = tuberculin residue, the residue after TO, the upper layer, has been removed by washing and then subjected repeatedly to the action of oxygen until no residue is left. It contains the constituents of tubercle bacilli insoluble in glycerin. The dose for injection is 0.0003 — 0.0005. gm.

In addition to the use of tuberculinum Kochii P. G., tuberculin A., Koch's old tuberculin, used for both diagnosis and treatment, and the new tuberculin, tuberculin R. (Koch) used for treatment only, the following forms (*Extra Pharmacopeia*, p. 875) have been placed on the market by the manufacturers of Koch's tuberculins:

T. O. A. i. e., tuberculin-original-Alt. (Alt. = old.) A germ-free tubercle-bacilli-bouillon resulting from filtering fully-grown nutrient cultures of bacilli (*typus humanus*). In 1 and 5 cc. bottles.

P. T. O. i. e., Perlsucht-tuberculin-original. (Perl-sucht, = Pearl disease, i. e., tuberculosis of serous membrane of cattle producing pearly nodules or tumors often pendulous). Is exactly like the above excepting that it is prepared from the tubercle bacilli in cattle (*typus bovinus*).

Vacuum-tuberculin is obtained by reducing T. O. A. at a low temperature and in partial vacuum to one-tenth of its volume. It differs from the old tuberculin in that old tuberculin is strongly heated. It consists of toxins produced by the bacilli during their cultivation. Old tuberculin, on the other hand, contains, in addition to toxins, endotoxines extracted from the bacilli at higher temperatures. It is sold in 1 and 5 cc. bottles.

Bovine-vacuum-tuberculin corresponds to vacuum-tuberculin last mentioned excepting that bovine bacilli are used. In 1 and 5 cc. bottles.

These vacuum preparations are introduced on account of their better keeping qualities.

New bovine tuberculin (*Tuberculin P. T. R.*) is equivalent to T. R. excepting that bacilli typus bovinus are used.

Procedure and dosage of the above five agents. These are exclusively for treatment of patients exhibiting a very violent reaction to old-tuberculin or other similar preparation, as well as for treatment of those with a permanent or intermittent febrile temperature and not for diagnosis.

Dilute 1 cc. of any one of the above with 9 cc. 0.5 per cent. phenol. The manufacturers term this 10 cc. of vacuum tuberculin, bovine-vacuum-tuberculin dilution, or tuberculin dilution 1; the 10 cc. of T. O. A. or P. T. O. dilution, tuberculin dilution 2.

If 1 cc. of tuberculin dilution 1, made from vacuum tuberculin or bovine-vacuum-tuberculin, be further diluted with 9 cc. 0.5 per cent. phenol solution, tuberculin dilution 2 is obtained, and by dilution of the tuberculin dilution 2 from T. O. A. or P. T. O., tuberculin dilution 3 is obtained, etc.

The different dilutions compare as follows: Each 1 cc. T. O. A. or P. T. O. corresponds to 1 cc. tuberculin dilution 1 (because vacuum and bovine-vacuum tuberculin are concentrated 10 times strength of T. O. A. and P. T. O.).

It is intended that the physician should by trial injections select for each case the preparation most suited. Commence with 1 cc. of a tuberculin dilution 5, i. e., with 0.0001 cc. T. O. A. or P. T. O., or 0.00001 cc. vacuum or bovine-vacuum-tuberculin. If no marked reaction appears continue with the stronger preparation, No. 4, and so on. If the reaction be violent even from this small dose, after a few days' interval, the trial is repeated with one of the other preparations. In the course of the treatment as a rule no change is made in the preparation employed, but frequently patients with great sensitiveness lose it in the course of treatment and it is then advantageous to continue the treatment with the more active preparations, old tuberculin, bovine-tuberculin, or with tuberculin T. R. or with bacilli emulsion.

Behring's tulase. This clear liquid is of honey consistence, said to contain all the constituents of the Koch bacillus. Used subcutaneously, intravenously or *per os*. The *British Medical Journal*, however, says, that the application of this cure is complicated.

Tulase-lactin is tulase with milk intended to immunize infants.

Behring himself speaks against too much reliance on its curative properties.

Beraneck's tuberculin is a mixture (claimed to be innocuous) of equal parts of a basiotoxin derived from veal broth cultures of *bacillus tuberculosis* and an acidotoxin from the bacilli themselves.

Buchner's tuberculin, or *tuberculo plasmin* is a filtered watery solution of the protoplasm of moist living tubercle bacilli extracted by hydraulic pressure.

Deny's tuberculin is the same as BF.

Diron's tuberculin is prepared by treating cultures of living tubercle bacilli with ether and extracting in salt solution.

Hamm's tuberculin is a tuberculo-albumin closely resembling *tuberculase*, an extract of tubercle bacilli for protective inoculation against tuberculosis.

Hirschfelder's tuberculin (*oxytuberculin*) is made from cultures of a very virulent tubercle bacillus modified by oxidation with hydrogen dioxid.

Klemperer's tuberculin is prepared from cultures of bovine tuberculosis.

Landmann's tuberculin (*tuberculol*) is said to be free of secondary products, containing culture fluid and bacterial cells.

Marogliano's tuberculin. See p. 7596, Vol. X of this *Encyclopedia*.

Rosenbach's tuberculin is prepared from tubercle bacilli and cultures that have been infected by the *trichphyton holosericum album*, thus reducing the toxicity of the former.

Ruck's tuberculin is prepared by filtering the tubercle bacilli from virulent cultures, drying, powdering and extracting them with ether.

Spengler's tuberculin is a preparation of bovine tuberculosis.

At this point the reader is referred to such captions as **Tuberculosis of the eye**; **Calmette's ophthalmo-tuberculin reaction**, p. 1361, Vol. II; **Pirquet's test**, p. 10228 in this *Encyclopedia*.

A review of the more important and reliable observations regarding the *employment of tuberculin in ophthalmology* from 1909 to 1919 is given as follows:

John Green Jr. (*Interstate Med. Journ.*, p. 883, Nov., 1910) remarks that since the appearance of v. Hippel's paper (v. Graefe's *Archiv.*, 1904) on the *tuberculin treatment of ocular tuberculosis*, the method has received general acceptance at the hands of ophthalmologists throughout the world. The nature of ocular tuberculosis, thanks to research and clinical experience, is being better and better understood. As a rule the primary focus is in the lungs, but is very frequently undiscoverable owing to the absence of fever and

physical signs. Recognition of the fact that the disease in the eye is not (except in rare instances) primary, has led to the abandonment of enucleation, which formerly was generally resorted to in the (mistaken) expectation of preventing general dissemination.

There are two types of ocular tuberculosis: the benign and the malignant. Cases of the former frequently recover under ordinary non-specific therapeutic methods (fresh air, nourishing food, rest, etc., combined with appropriate local treatment). The malignant cases are often associated with general tuberculosis, and it is in these that the most striking effects of tuberculin are observed.

According to Stahli, the most that we can expect to attain by tuberculin injections is an immunity to toxins. Old tuberculin provides a tuberculo-toxin which is necessary to confer toxin-immunity. It may be used in afebrile patients. New tuberculin and bacillus-emulsion contain disorganized bacilli "in order to confer a problematic immunity to tubercle" (not yet attained in the human), and may be given to febrile patients. The question as to the relative efficacy of the mild (reactionless) and the vigorous (reaction) methods is still sub judice, with present tendencies favoring the former.

Junius (*Ophthalmology*, Jan., 1910) states that "the correct application of tuberculin is an art which must be learned." There is no absolutely "best" tuberculin, though tuberculin (T. R.) is more manageable. Better still is Beraneck's tuberculin, the action of which is mild and easy of regulation. Injection should be made not more often than twice a week. In children the cure should commence with an initial dose of 1/20 c.cm. of Beraneck's solution A 128. In adults 1/20 c.cm. of Beraneck's solution A 32. The dose should be slowly increased.

Rollet and Aurand (*Révue Gén. d'Ophthalm.*, Jan. 31, 1910) inoculated the anterior chamber of rabbits with tuberculosis culture and then tested the therapeutic action of bacillus-emulsion in various standard dilutions. They conclude that (1) slowly progressive injections of B. E. are not injurious to the rabbit; (2) the temperature reactions to the maximum dose, at first nil, appear only after a month of treatment, and remain always very variable in spite of the identity of the dose; (3) the temperature reactions are proportional to the virulence of the tuberculosis rather than to the quantity of tuberculin injected; (4) the temperature reactions increase with repeated injections of the same dose (a phenomenon of anaphylaxis); (5) in consequence of (4) the therapeutic technique should vary for each animal and the doses of tuberculin should perhaps be diminished instead of increased in course of treatment; (6) B. E. has a very

slow action on tubercles; it does hasten the retrogression of tubercles of the iris, but it does not prevent generalization of the disease, even in cases of complete local cure; (7) in control animals, tuberculosis of the iris might cure spontaneously, but in all cases there was generalization in the liver.

One question which has proved especially vexing is whether a determination of the opsonic index is necessary or even advantageous in the tuberculin treatment of eye-diseases. Stock (*Klin. Monatsbl. f. Augenheilk.*, Nov., 1909) found that small doses at long intervals brought about a rise in the opsonic index in most cases, but these doses were without favorable effect on the patient's condition. For definite therapeutic effect, doses higher than were required to work a rise in the opsonic index were invariably required. Stock came to rely wholly upon clinical observation as a guide to the effective dose, choosing the highest dose which the patient stands without reaction. Another important point determined by Stock is that there is a marked change in the opsonic index after the artificial irritation (as by the instillation of dionin) of an eye which is the seat of a tuberculous lesion. The diagnostic value of this test is considerable.

A. E. Davis (*Ann. Ophthalm.*, Jan., 1914) writes on the *diagnostic and therapeutic uses of tuberculin in eye diseases*. His conclusions are: 1. We may safely state that the tuberculin reaction tests play a part as important in arriving at a correct diagnosis in tuberculous diseases as does the Wassermann reaction in syphilitic diseases. Both are often of the utmost value in making a differential diagnosis.

2. As a therapeutic agent, tuberculin, used in the right way, is the most valuable remedy we possess in the treatment of ocular tuberculosis. Used consistently, and persistently over a long course of time, the results accomplished at times are little short of wonderful. But it should be ever kept in mind that we are dealing with a powerful toxin, and with one that is capable of doing much harm if not properly given, and in the right dose. Each patient must, therefore, be individualized and treated according to his or her reaction to the remedy, for we are dealing with a remedy that is not a cure in itself, but acts by stimulating the body cells to manufacture the "antibodies" or protective materials for its own defense against the tubercle bacillus.

W. B. Weidler (*New York State Journ. of Med.*, Sept., 1915) gives the status (to the date of his article) on *tuberculin therapy*. He points out that the idea of tubercle bacilli as the cause of eye diseases is more generally accepted than it was ten or twenty years ago; and

many previously obscure lesions of the retina and the choroid are now comparatively simple to diagnose and treat.

He believes that the most essential factors in the successful treatment of ocular tuberculosis are, first, a slow and gradual increase of the dose extending over weeks and months; careful preparation of the tuberculins; subcutaneous injection rather than intramuscular; and the local and general treatment of the ocular lesion with the same means that were employed before tuberculin was added to our therapeutics.

The results he cites in his paper are based upon an experience with 117 cases of tuberculous affections of the conjunctiva, cornea, sclera, iris, ciliary body, retina and choroid.

He concludes that 1. A positive reaction may not be as dependable in suspected ocular lesions of tuberculosis as a positive Wassermann reaction is in suspected ocular lesions of syphilis, but it is at least a strong indication for tuberculin therapy. 2. Tuberculin as a therapeutic measure has an assured place in the domain of ophthalmology. 3. He believes that many failures from tuberculin therapy have been due to faulty technique; not continuing the treatment long enough; imperfect and inert tuberculin vaccines; or the use of the wrong tuberculin vaccines. 4. It may be necessary to change tuberculins when we do not get good results from one kind and use some other form of tuberculin vaccines. 5. The ophthalmologist who is not using tuberculin as a diagnostic agent and as a therapeutic measure is not practising modern ophthalmology.

C. A. Clapp (*Archives of Diagnosis*, p. 399, Oct. 1, 1917) writes on the *diagnostic value of tuberculin in eye lesions*. He points out that the methods in use at the present time in arriving at a conclusion that the lesion is tuberculous are: 1. The ophthalmic reaction (Wolf-Eisner, Calmette). 2. The cutaneous reaction (Von Pirquet). 3. The sub-cutaneous diagnostic injection of old tuberculin (Koch). 4. Focal reaction following increasing therapeutic doses.

Taking these methods in detail as to their value and adaptability the following comments apply:

1. "The *ophthalmic reaction with tuberculin* may show in general work that the lesion is in an active stage, but should be used with great caution, and certainly never in an eye which has a suspected local tuberculous lesion. Violent reactions have followed its use with permanent loss of vision due to corneal ulceration.

2. "The *cutaneous reaction of Von Pirquet* has no contra-indications, as damage to the eye never results, but on the other hand very

little knowledge of positive nature is obtained. If the reaction does show positive, it may be taken as suggestive, but since about seventy-five per centage of adults show some reaction, even its suggestiveness diminishes with increased age of the patient. If the reaction shows negative, it is also of little value, as experience has shown that cases which are negative to the skin reaction, very frequently show focal reaction, under tuberculin therapy; therefore, Von Pirquet's reaction, either positive or negative, is of very limited value in the differentiation of the etiology of eye lesions.

3. "The *sub-cutaneous injection of T. O.* For convenience of discussion this reaction may be subdivided into (a) General reaction; (b) Focal reaction. (a) General reaction: If following a diagnostic dose there is a febrile reaction of one or more degrees Fahrenheit coming on within six or eight hours, and especially if accompanied by a local reaction, it is very good evidence that there is a tuberculous lesion some where, but if no focal reaction is produced, the tuberculous lesion is probably outside of the eye. One can hardly conceive of an eye lesion which would liberate sufficient toxins into the general circulation as to cause a febrile reaction, without causing some focal reaction. The danger to sight is very great in large diagnostic doses. (b) Focal reaction: This is the reaction of real value to the ophthalmologist. Hamman and Wolman say in their *Tuberculin in Diagnosis and Treatment*, that this is the reaction of most value, but seldom do we have an external lesion where the reaction can be seen. Thus is tuberculin of so much more value to the oculist, as he has direct observation of the lesion, either in an external trouble, or if internal, in most cases under direct view by means of ophthalmoscopy.

"Now as to what constitutes a reaction. If the lesion is corneal there is seen an increase in the circumcorneal injection with an extension of infiltration into the cornea. It is not necessary to have a reaction that a layman can see across the room to be called a focal reaction, but as one watches the eye, slight increase in the circum-corneal redness after each injection can be seen, or in edema of cornea or extension of infiltration into deeper layers. If iritic, there is an increased circum-corneal injection with more numerous deposits on Descemet's membrane and some increase in cloudiness of aqueous; if choroidal or retinal, the lesion shows greater activity, in increased edema and cloudiness of the vitreous, and possibly fresh hemorrhages if the blood vessels be chiefly affected. All these macroscopic changes may be from very slight to very pronounced in degree."

Size of dose. "There is no such thing as an average size diagnostic dose. If the lesion under investigation is corneal, where the vascular

supply is very deficient, then a large diagnostic dose, one to ten mg., can be used with impunity, as these lesions show a very great indifference to reaction. While one mg. is usually sufficient to provoke a reaction and seldom is it necessary to go beyond this amount, yet occasionally one may find a focal reaction with the larger dose of ten mg. which has not reacted to the smaller doses. When the lesion involves the iris, a smaller initial dose should be used, depending upon the activity of the lesion. In an acute condition a one-half mg. T. O. will not produce too violent a reaction, while in the more or less chronic conditions, a painful or harmful reaction will not result from even five mg. But when we are dealing with a choroidal or retinal lesion and especially if near the macula, then as a rule only the smallest doses should be used, and should the lesion be very acute, it is most dangerous to use any diagnostic dose, and it is strongly recommended that the eye be put at rest; general hygienic measures instituted and wait until the lesion becomes sub-acute or chronic before using a diagnostic dose, and even then it is better to start with exceedingly small therapeutic doses and increase until a general or focal reaction results. In other words, we should never allow our scientific zeal to render an absolutely correct diagnosis, overcome our judgment as to conservative treatment.

4. "The *focal reaction following therapeutic doses*. Under this heading come a fairly large group of cases that one sees in our dispensaries and occasionally in private practice—the so-called neglected cases, which have allowed damage to sight to occur before calling for help, or that class of patients who make too frequent changes in their medical attendants. When such a case comes, with the cornea, aqueous, pupil or vitreous so cloudy that the exact location, extent, or acuteness of the lesion cannot be determined; or in those acute cases where the lesion is centrally located, a diagnostic dose would be decidedly dangerous. If after careful investigation all other possible sources of etiological factors prove negative and all points of focal infection be eliminated, it is then highly advisable to start in with very, very minute doses of the tuberculin sub-cutaneously, gradually increasing the dose until some focal reaction is noted, or until there is seen some actual improvement in the condition. Here again one could with justice ask what we mean by a very minute dose. If T. O. is being used 1:500,000 mg. is not too small as the initial dose, while the T. R., which is the preparation we have had most experience, may be used in a little larger dose; 1:300,000 mg. never having proved harmful in our work. One frequently sees a beginning improvement in the eye before a focal reaction, but in these

cases almost without exception the focal reaction appears sooner or later.

"After one has watched several of these lesions that have persisted for months with no improvement under various lines of treatment suddenly begin to improve after tuberculin injections, it is impossible to be convinced that the changes are entirely coincidental.

"These observations have therefore brought us to the following conclusions: (1) That a differential diagnosis between the different eye lesions as to etiology cannot be made from clinical observations alone. (2) That if all other tests are negative and we obtain a focal reaction we are reasonably certain in our diagnosis. (3) That the size of the diagnostic dose is not the same but varies widely as to the location of the lesion, and as to its stage of activity. (4) That occasionally the media are so cloudy, or the lesion so acute, that no diagnostic dose should be given, and in such cases a minute therapeutic dose should be given and gradually increased until a reaction is produced, or until we eliminate the tuberculous element as an etiological factor. (5) Never be so aggressive in the diagnosis of the etiological factor as to permanently damage the sight."

John E. Weeks (*Am. Journ. of Ophthalm.*, Oct., 1918) believes that in establishing a *diagnosis of a tubercular process in the eyes*, the subcutaneous injection of old tuberculin T. O., is the procedure now generally considered to be the best. Trudeau found that the subcutaneous injection of 9 mg. of old tuberculin will produce a rise of temperature in a healthy adult; hence it is necessary to employ a smaller dose in conducting this test. In his experience it was perfectly satisfactory to begin the test with 1 mg. in the adult, $\frac{1}{2}$ mg. in children. (The temperature of the patient should be taken twice in twenty-four hours for one or two days before giving the injection and the injection given only if the temperature is normal).

The injection is repeated if no local reaction (at the site of the inflammatory process in the eye) is obtained forty-eight to seventy-two hours later, provided the patient's temperature has remained below normal for the preceding twenty-four hours, using 2 mg., and again in forty-eight to seventy-two hours, using 3 mg. if a satisfactory reaction is not obtained by the smaller dose. It may be justifiable in certain cases to use a larger dose, as in some cases of small tubercular foci the smaller dose is not sufficient to excite the reaction.

The *local reaction* in conjunctival tuberculosis is indicated by an increase in hyperemia at the site of the lesion. In scleral and corneal lesions there is increase in pericorneal injection, the conjunctiva

nearest the lesion being most affected, slight increase in the density of the tissues at the lesion and in cloudiness of the immediately adjacent cornea. In iris tuberculosis an apparent exacerbation of the process is manifest by increase of hyperemia at the base; slight enlargement of the tuberculous masses and haziness of the aqueous over the lesion. If the white, fluffy "mutton-fat" exudation is present this may be slightly increased in amount. Some increase in pericorneal injection and slight pain referable to the eye may be produced. The same changes may also occur in ciliary tubercular processes.

In tuberculosis of the choroid the haziness over the affected area may be increased, the area involved slightly enlarged; and minute grayish punctate patches appear at the margin of the lesion, and vision becomes more impaired. In tuberculosis of the retina and optic nerve head similar changes may be produced. In order to observe these changes the eyes must be examined from time to time from twelve to thirty-six hours after the injection, and the condition compared with that preceding the injection. The reaction in the lighter cases may subside in six or eight hours, and in the severe cases seldom lasts more than forty-eight hours. The condition of the eye, after subsidence of the reaction is usually better than before the tuberculin was given. In no case has the eye been made worse in the writer's experience. In some cases the local reaction was extremely slight, and in some cases of undoubted tuberculosis no local reaction could be detected.

It must be borne in mind that it is not impossible for *tuberculosis and syphilis to exist in the individual at the same time*; and that the one process may modify the other so that a nodular iritis or a disseminate choroiditis may be influenced by both diseases. The writer observed two such cases affecting the iris. It is, therefore, desirable in many of the cases to make the diagnostic tests for syphilis as well as for tuberculosis; and in the cases in which both are positive to institute treatment for both at the same time. In fact it is the practice of the writer to give mercury and potassium iodid in moderate dose in very many of the cases in which tuberculosis of the eye exists, as well as to employ general tonic measures in the broad sense of the term.

Weeks concludes that *tuberculin should be employed as a therapeutic agent*, (1st) in all cases of diseases of the eye and its adnexa in which a local reaction is excited by the subcutaneous introduction of test doses of tuberculin; (2nd) in those cases of suspected tuberculosis (a) in which a general reaction to tuberculin has been ob-

tained; (b) in those cases of chronic affection of the eye in which a diagnosis is doubtful and in which therapeutic doses of tuberculin prove to be beneficial.

In a review of this remedial agent Ervin Török (*Archives of Ophthalm.*, p. 255, May, 1919) concludes that an eye should be regarded as tuberculous only when a positive focal reaction has been observed. In cases where a positive focal reaction cannot be obtained but the patient shows a positive local and general reaction and other possible cause for the eye symptoms are excluded, we may regard the case one of probable tuberculous origin. For therapeutic and diagnostic purposes tuberculin should not be more than two weeks old. The writer regards the subcutaneous injection of the agent as the most reliable form; and it can be used in children as well as in adults without danger. Tuberculin is a valuable and harmless remedy in ophthalmic therapeutics provided it is used in very small doses and in eye affections in which a positive focal reaction has been obtained. Treatment should begin with 1/10,000 *mgm.*, increasing it slowly to the maximum dose—that of toleration. In no case should it exceed 1 *mgm.* The treatment should be of long duration. Relapses are frequent in those cases where exhibition of the remedy has been discontinued after an apparent cure following treatment of less than eight months; indeed the best results have followed in cases of continuous treatment for several years and in which, after an apparent cure, the maximum dose was given once every three or four months. Tuberculin is of small value in chronic uveitis, except heterochromic cyclitis. It is very satisfactory, however, in scleritis, deep and superficial keratitis, iridocyclitis and periphlebitis retinae. Exudative choroiditis is rarely tuberculous; hence is not affected by tuberculin injections.

Tuberculosis of the eye. OCULAR TUBERCLE. This important subject has already been discussed under various captions in this *Encyclopedia*, and the reader is referred especially to such headings as **Bacillus tuberculosis**, p. 746, Vol. II, and to several sub-heads (dealing with the same matter) under **Bacteriology of the eye**. See, also, accounts of the disease as it affects the various parts and organs of the visual apparatus, in, *e. g.*, **Choroiditis, Tubercular** [preferably, *tuberculous*], p. 2159, Vol. III; **Cyclitis, Tubercular**, p. 3626, Vol. V; **Conjunctiva, Tuberculosis of the**, p. 3062, Vol. IV; **Orbit, Tuberculosis of the**, p. 9187, Vol. XII; **Cornea, Tubercle of the**, p. 3494, Vol. V, as well as **Keratitis, Tubercular**, p. 6818, Vol. IX and **Keratitis, Phlyctenular**, p. 6798, Vol. IX; **Eyelids, Tuberculosis of the**, p. 5026, Vol. VII; **Iris, Tuberculosis of the**, p. 6641, Vol. IX; **Lachrymal tu-**

berculosis, p. 6982, Vol. IX; **Dacryocystitis, Tubercular**, p. 3723, Vol. V; **Optic nerve, Tubercle of the**, p. 9080, Vol. XII; **Retina, Tuberculosis of the**, p. 11326, Vol. XV; **Sclera, Tubercle of the**, p. 11607, and **Scleritis, Tuberculous**, p. 11635, Vol. XV.

As early as 1865 Villemin showed that tuberculosis is a specific, inoculable disease. The *bacillus* associated with it was probably seen first in microscopic sections by Baumgarten in 1882, but the true nature of the tubercle bacillus and its rôle in the etiology of tuberculosis was not established on a firm basis until Robert Koch in 1884 (*Mitt. a. d. k. Gesund.*, 1884, v. 2, p. 1) so masterfully proved its presence in tuberculous lesions, grew it upon culture media, and later successfully performed inoculation experiments with isolated cultures, and thus conclusively demonstrated it as the causative organism of the disease.

There are several types of the bacillus, i. e., human, bovine, avian, and others.

The human bacillus tuberculosis ordinarily, in films prepared either from sputum or from cultures, appears as a slender rod, often curved, about 2 to 4μ long and 0.3 to 0.5μ broad. Occasionally in sputum and more often in cultures, long filamentous growths are seen. They are sometimes branched and have hypha-like filaments which occasionally have swollen ends. The bacillus is surrounded by a waxy capsule which plays an important rôle in the peculiar differential staining qualities of the organism. With ordinary aqueous analin dyes the organism stains imperfectly or not at all, but with the aid of a mordant and heat the dyes penetrate the organism and it becomes deeply stained. When stained in this manner the organism almost invariably retains its color even when subjected to the action of alcohol and mineral acids and, because of this characteristic, it is classified among the acid-fast or acid-proof bacilli. v. Behring (*Tuberculosis*, 6, No. 9), however, describes tubercle bacilli without this quality. The stain ordinarily used in the study of these organisms is Ziehl's carbol-fuchsin solution. It is applied to the preparations and heated and followed by a decolorizing solution which is 2 per cent. hydrochloric acid in alcohol, which removes the stain from all except the tubercle bacillus. A contrast stain, usually methylene-blue, is then applied. By this procedure the tubercle bacilli are stained red while all tissues and other bacteria are colored blue.

The organism grows poorly on ordinary culture media when transferred directly from a tuberculous lesion, but secondary cultures grow more rapidly. Dorset's egg medium affords a simple and easy method of isolating the bacillus from the tissues. The best development of

the bacillus occurs between 37° and 38° C. Growth usually ceases above 42° and below 23° C.

In man practically every organ and tissue of the body may be affected by the tubercle bacillus. The lungs most frequently are involved but the intestines and mesenteric glands, the larynx, the skin, the lymph glands of the head and neck, the liver, the bones and joints, the pleura and peritoneum, and the uro-genital system are frequently attacked. The eye may become involved in a tuberculous process, but is not so frequently a seat of the disease as the other parts of the body above mentioned.

Tuberculosis is rarely inherited, but children of parents who have the disease or who are exposed to infection through others affected with it, very frequently contract the disease because the human being is naturally very susceptible to the tubercle bacillus. This is especially true in the young and when infants are exposed to the infection many of them contract the disease. However, if children of tuberculous parents are placed in surroundings in which they are not exposed immediately after birth, they do not as a rule develop tuberculosis. (Fishberg.)

The portals of infection are, first, the respiratory tract through which the organisms, during the act of breathing, are drawn into the body from the air which has become contaminated by the coughing, sneezing, or talking of tuberculous persons, and by dust which contains dried germ-laden sputum; second, the alimentary tract through which the germs gain entrance into the body from contaminated food, from the common drinking cup, from imperfectly cleansed dishes or table silver, and from milk and its products from tuberculous cattle; this is especially true in the case of children whose chief article of diet is milk; third, inoculation, which condition occasionally occurs by the organisms gaining entrance accidentally through the skin or subcutaneously.

Cattle are especially susceptible to tuberculosis and swine are frequently diseased. Laboratory animals, particularly the guinea pig, are susceptible to artificial inoculation but do not contract the disease under natural conditions. Chickens, pheasants, turkeys and pigeons suffer from this disease, while ducks and geese are exempt.

Only the human and bovine organisms concern us here. The other strains which exist in nature are of little importance in human pathology. Both the human and bovine strains produce the disease in man, but the human type possesses the greater virulence and produces the more typical lesions and symptoms.

After the bacillus has entered the body of a susceptible person cer-

tain characteristic changes take place in and around the area where the bacilli have lodged. The presence of bacilli in the tissues stimulates the formation or migration of large cells which possess endothelial characteristics. The cells contain a large, oval, lightly staining nucleus which is curved and indented and usually eccentrically situated in a non-granular cytoplasm. These cells are variously called, by different authors, endotheloid cells, epitheloid cells, or endothelial leukocytes. They accumulate around the organism and attempt to neutralize the toxins generated by the bacteria and thus oppose its injurious effect. Polymorphonuclear leukocytes are occasionally present in varying numbers. It is only rarely that they replace the endotheloid cells. If the bacilli are extra-vascular, i. e., in the tissues, in the acute stage, to the leukocytes serum and lymphocytes are added. Occasionally other cells, such as eosinophiles, may be present and fibrin may form from the serum.

As a rule in the earliest stages the disease begins in the minute blood or lymph channels but occasionally it starts in the larger vessels. In the lung the alveolar lining is often first attacked. The appearances of these earlier lesions vary with the structure first involved. If the process begins in the larger vessels the migration of endotheloid cells can produce a cell thrombosis. When the bacilli obtain access to lymph channels, which are surrounded by loose tissue, tuberculous inflammatory exudate occurs into the surrounding tissue.

The endothelial cells in a tuberculous lesion have a marked tendency to fuse together and to form multinucleated cells, the so-called giant cells. The nuclei of a tubercular giant cell are frequently arranged in the periphery of the cell,—giant cells of the Langhans type. The giant cells form a striking picture, but are not, in themselves, a diagnostic feature of tuberculous lesions for they develop in other conditions also. The giant cells are usually found near the center of the lesion with the endotheloid cells and leukocytes. Towards the periphery of the lesion round cells and fibroblasts appear a little later in the disease. Because of the poor blood supply to the tuberculous areas necrosis of the cells takes place in the center of the lesion and advances toward the periphery. The tubercle at this stage is typical of the disease and presents a central area of caseation necrosis which is surrounded by endothelial cells and leukocytes and a peripheral zone of small round cells. In the early stages the lesions appear as small tubercles and it is from this appearance that the disease derives its name. The presence of tubercle bacilli in the lesions positively demonstrates the existence of the disease. However, these cannot always be found because they occur in such widely varying numbers in the

lesions which they produce. In some instances the bacilli are numerous while in others they are few in number, and often many sections must be carefully examined before one bacillus is discovered. The tubercles may remain localized in one area or the germs may enter the general circulation and produce a generalized miliary tuberculosis. One or several tubercles may be present in the same organ and, if the disease is progressive, several small tubercles may coalesce and form a large tuberculous mass the center of which undergoes necrosis and caseation. In the more favorable cases the fibroblasts in the round cell zone of the tubercle proliferate and surround the lesion entirely. Later they produce collagen fibers which fuse together and become a firm scar which surrounds the diseased focus and thus limits the spread of tubercle bacilli. The necrotic tissue in the lesions frequently attracts lime salts and the lesions become calcified.

If the healing process is retarded, the caseous areas occasionally become liquefied and form the so-called cold abscesses. Small abscesses near the surface may rupture and become ulcers.

Tuberculosis occurring in an organ is either of primary or secondary origin. If primary, it is the first organ of the body to become affected by the disease and the inoculation occurs through one of the portals previously enumerated. If secondary, the area involved is attacked by tubercle bacilli or by their toxins which have passed from the original primary lesion either by continuity or carried by the blood or by the lymph. It is often difficult, and at times impossible, to determine which type we are dealing with. When we are sure that the lesions are of the secondary variety, the primary focus, even after a prolonged and exhaustive search, cannot, in many instances, be positively located.

We cannot always ascertain whether ocular tuberculosis, especially of the chronic type, is due to the presence of the human or bovine strain of the bacillus. The only means which we have at present for the differential determination of the bacilli are animal inoculation and the study of cultural characteristics.

All tissues of the eye may become involved in a tuberculous process. Even the lens has been reported as having been invaded by the tubercle bacillus, but a tuberculous phakitis, unassociated with tuberculosis in other portions of the eye, is unquestionably very rare. When the tubercle bacillus attacks the eye the involved tissues undergo the characteristic changes which occur in tuberculosis of other portions of the body, and one who is familiar with the pathology of this disease, can readily understand the reasons for the visible changes that occur in various parts of this organ.

The primary, non-traumatic, form of tuberculosis of the eye is rare,

and it is confined to the lids, conjunctiva, cornea, caruncle, and lachrymal sac, viz., to areas which are directly exposed to the invasion of tubercle bacilli from external sources, i. e., air, dust, etc., and is exogenous. Following wounds which penetrate the eyeball and permit the entrance of tubercle bacilli into the eye, any of the eye tissues may become primarily involved in a tuberculous process, and the infection would, evidently, be of exogenous origin. Primary tuberculosis of the iris, optic nerve and other intraocular tissues, not associated with trauma, has been reported, but it is probable that an undiscovered latent tuberculous focus existed in some portion of the body and was the source of the infection. It is frequently very difficult and often impossible, as before mentioned, even where a marked constitutional reaction to tuberculin is obtained, to locate the primary tuberculous focus and in such cases there is a temptation for the observer to classify the ocular lesion as primary. In the majority of cases ocular tuberculosis is secondary to tuberculosis in some other portion of the body and, with the exception of the type of choroidal tuberculosis that is associated with general miliary tuberculosis and tuberculous meningitis, the disease in the eye usually runs a chronic course. This gives us another classification which is clinical, i. e., acute and chronic.

The *acute types of tuberculosis* of the eye run a rapid course and the involved area is quickly destroyed by caseation and necrosis. In this variety the destruction is usually extensive, and if the patient does not die soon after the onset of the eye condition, the eye most often is converted into a tuberculous mass which necessitates enucleation.

The *chronic types* are more protracted, do not develop as rapidly, and often are confined, at least in the beginning, to one portion of the eye. The process may be active over a period of months or even years and recurrences of activity may manifest themselves at any time in an eye which was thought to be healed. Jackson states that one cannot be sure as long as the patient lives that the disease will not again become active.

It is only since Koch discovered the tubercle bacillus and proved its etiological significance, that the cause of many obscure eye manifestations was found to be due to this bacillus. Later when tuberculin was discovered, and its value as a diagnostic means was understood, clinicians had at their disposal a valuable aid with which to confirm their conclusions when they had made a diagnosis of tuberculosis from clinical findings.

At the present time the clinical characteristics of tuberculosis in some parts of the eye are well understood.

Speaking of *tuberculosis as a focal infection* Edward Jackson

(*Journ. Am. Med. Assocn.*, Feb. 14, 1920) draws attention to the fact that a type lesion occurs in the eye. He maintains that the single tubercle is the typical lesion of a focal infection; complete in itself. The crowding of many tubercles into one larger mass has always tended to obscure the real character of the disease, by raising issues and causing symptoms that were incidental and nonessential; it has tended to draw attention away from the smaller fields of the vital struggle in which the real battle of defense against the invader was being fought. But a single tubercle usually is not recognized in the living body. Generally a large number of single tubercles developed in the same region, as in a lymph node or a lobule of the lung, have been spoken of as the focus of infection.

Much that applies to the single tubercle applies to the larger mass; but a better insight into the nature of the disease began with the anatomic study, the microscopic analysis of the single tubercle; and there are important lessons still to be learned by the study of the evolution of such a lesion, and the careful noting of the symptoms it causes during life. Jackson says: "There is one place in the body where such a study is possible, the background of the eye; and when the ophthalmoscope has been properly and persistently employed in this investigation, we shall have learned some very important facts with regard to the pathology of tuberculosis. The tubercle present in the ocular fundus varies in dimensions, being 0.1 to 1 mm. or larger. It can there be watched often from its beginning to its complete involution. It may be recommended as a subject for study to all who are interested in tuberculosis."

Tuberculosis affects all parts of the eyelids. When the skin is involved, it is either primary or secondary. The primary form is not so common because the condition is usually associated with lupus involving the skin of the face. The clinical appearance and course of tuberculosis of the lid is fully described in Vol. X, p. 7548, of this *Encyclopedia*.

Tuberculosis of the lachrymal gland is a rare disease. It is generally secondary to tuberculosis in some other portion of the body and may occur at any age. The condition may be unilateral or bilateral and one or both glands may be involved. The first symptom noticed is slow enlargement of the gland which is not accompanied by a marked inflammatory reaction. If the enlargement is marked the eyeball becomes displaced. The process may go on to caseation and necrosis, and rupture through the skin or conjunctiva may occur and be followed by a fistula through which the contents of the tuberculous abscess and lachrymal secretion may drain.

Leblanc reported a case which occurred in a man forty years of age. In addition to a tuberculosis of the lachrymal gland the skin of the eyelid was involved.

Würdemann reported a case in which the periosteum of the forehead became affected after the removal of a lachrymal gland which had been found to be involved by tuberculosis. Treatment by the subcutaneous injection of tuberculin cured the periosteal condition.

The existence of tuberculosis of the lachrymal gland simultaneously with enlargement of the salivary glands and sublingual and cervical lymph glands has been reported. This group of symptoms has been confused with Mikulicz's disease. However, the demonstration of tuberculous changes in sections taken from the involved tissue makes the differential diagnosis. Some authors regard Mikulicz's disease as a syndrome which presents group symptoms, but has widely varying causes. See **Mikulicz's disease**, Vol. X, p. 7703.

Fage classifies tuberculosis of the lachrymal sac into three groups. First, tuberculosis localized in the sac; second, tuberculosis in the soft tissues around the sac, and third, lesions of the lachrymal and superior maxillary bones.

Tuberculosis of the nose is frequently associated with tuberculosis of the lachrymal sac, and it is possible that in many cases the condition in the sac is secondary to and an extension of the disease of the nose. Tuberculosis of the lachrymal sac is covered in Vol. IX, page 6982 of this *Encyclopedia*.

Lundsgaard (*Am. Jour. of Ophthalm.*, Feb., 1916) examined and treated forty-eight cases of *conjunctival tuberculosis*. In nineteen of the forty-eight cases lupus of the skin was not found, but in the remaining twenty-nine it was present.

The first nineteen cases were all unilateral and occurred in persons under twenty years of age, and the majority of the cases occurred in females. The lymph glands were involved in all cases and many of them suppurated. The upper lid was involved more often than the lower.

The conjunctival tuberculosis in the lupus patients occurred between the ages of six and fifty-two years, most frequently between twenty-six and thirty years, and more females than males were affected. Both eyes were involved in many cases and the upper lid was more often attacked than the lower. The lymph glands never suppurated and it is doubtful if they were swollen.

Lundsgaard rather leans to the belief that tuberculosis of the conjunctiva when not associated with lupus of the skin, is of endogenous origin and when associated with lupus it is of ectogenous origin.

In all ulcerations of the palpebral conjunctiva, when associated with enlargement of the preauricular or sub-maxillary lymph glands, the presence of tuberculosis should be suspected and not excluded until repeated laboratory tests, including microscopic examination, cultures and animal inoculation from scrapings and secretions, have proven negative. Numerous cases, in which the diagnosis of Parinaud's conjunctivitis had been made, later in the course of the disease were found to be tuberculous. Verhoeff has described a fungus which he believes is the specific organism of Parinaud's conjunctivitis and when it is found tuberculosis can be excluded. This fungus can only be found, however, by special staining methods. (See **Parinaud's conjunctivitis**, Vol. XII, p. 9361.)

Libby (*Ann. Ophthalm.*, Oct., 1914) reported a case of tuberculosis of the bulbar conjunctiva of the right eye which occurred in a woman 40 years of age. A number of small, pale, firm, reddish-white nodules were seen in the bulbar conjunctiva on the internus, and a large, firm, deep-red nodule under the somewhat infiltrated plica. The cervical glands on the right side had been enlarged for a month before any signs of the disease were noticed in the right eye. No tubercle bacilli were found in smears or scrapings made from the conjunctival lesions. A focal reaction was obtained after a subcutaneous injection of tuberculin.

Basterra (*Plus-Ultra*, Madrid, Apr. 1919) reports that he has encountered both primary and secondary tuberculous lesions in the conjunctiva. He found it more frequent in girls and women than in men; the majority of the patients were between 10 and 30 years old. The conjunctiva of the lids and tarsus is the usual site, but the clinical differential diagnosis is not sufficient. If the lesion is not extensive, it yields readily to applications of 50 per cent. lactic acid.

Tuberculosis of the conjunctiva is also described in Vol. IV, p. 3062.

For a long time tuberculosis has been considered as one of the causes of *phlyctenular conjunctivitis and keratitis* while more recently several observers have advanced this condition as being the foremost among the causative agents. Suker believes that phlyctenules are low grade tuberculous inflammations of the conjunctiva and cornea and that they often are the result of the toxic agents of tuberculosis engendered somewhere in the body and that frequently the bacilli are not found in the eye lesion. Phlyctenules, in many cases, are caused by tuberculosis but they are also caused by other constitutional factors, and the subject should be carefully examined to determine the presence or absence of any tuberculous taint. Phlyctenulosis is discussed in Vol. II, p. 832, and Vol. V, p. 3131 of this *Encyclopedia*.

Tuberculosis of the cornea is rarely primary and when it does occur

it is due to direct inoculation of the bacilli into its substance. Panas and Vassaux (*Arch. d'Ophth.*, 1885, p. 193) succeeded in producing tuberculosis in the cornea of rabbits by direct inoculation. The uveal tract is usually involved in the tuberculous process and the corneal condition is, as a rule, secondary either to the uveitis or to the conjunctiva or sclera. One or both eyes may be affected.

Lotine classifies keratitis of tuberculous origin into three groups. The first group is a typical tuberculous parenchymatous keratitis distinguishable from parenchymatous keratitis of syphilitic origin by a more or less diffuse opacity limited to one part of the cornea which does not invade the whole cornea as syphilis does. Small points of whitish-yellow infiltration are found in the middle and deeper layers of the cornea and are isolated tuberculous nodules. They are usually located in the peripheral portion of the cornea but sometimes are found in the central part. Vascularity is never so pronounced as in the vascular form of syphilitic keratitis. Sometimes, in addition to these clinical features, episcleritic nodules or infiltrates near the limbus, periodic eruptions of miliary phlyctenules, typical scleritis, or iritis with tubercles are found. The affection is usually monocular but may affect both eyes. The second form is a simple parenchymatous keratitis characterized by diffuse opacity occupying only part of the cornea and is associated with slight pericorneal injection. The third form is the typical scrofulous or phlyctenular kerato-conjunctivitis. Lotine suggests that it might be called paratuberculous keratitis since there is a tendency to look upon scrofula as an attenuated tuberculosis or para-tuberculosis.

In addition to the above classified lesions tuberculosis may produce a sclerosing keratitis which consists of modified tubercles in the corneal substance and appear as grayish opacities resembling cold mutton fat. They are either superficial or deeply situated and may lead to ulceration of the cornea. Ulceration in most instances is secondary to the superficial variety of infiltration.

Corneal tuberculosis is seldom present without some manifestation in the sclera but the scleral involvement may not be noticed until the cornea has been diseased for a long period of time. When ulceration is present the pre-auricular and infra-maxillary glands are usually enlarged. The disease is essentially chronic. In the parenchymatous and sclerosing forms the symptoms often are not annoying and the patient only complains of slight photophobia, increased lachrymation, in some cases slight pain which is usually deeply seated, and impairment of vision. The degree of visual impairment depends on the density of the corneal infiltration. In the superficial form the symptoms

are more severe. A muco-purulent secretion is present, the palpebral conjunctiva is injected, and the bulbar conjunctiva is swollen.

The nodular opacities are miliary tubercles which are modified by the unfavorable tissues in which they are located. The infiltration of the cornea is most dense surrounding the foci. When the entire cornea is involved, which is not the rule, the density of the opacity varies in different parts but the opacity is rarely as dense as in the syphilitic variety. See **Keratitis**, Vol. IX, p. 6818.

Tuberculosis of the iris was first described by von Graefe as a granuloma. He based this terminology on Virchow's report that the microscopic appearance of sections of the iris which had been removed because of this condition, resembled granulation tissue.

Tuberculosis of the iris occurs as one solitary tubercle which resembles a neoplasm or as disseminated tubercles. It is found most often in the youth, occurring usually between the ages of five and twenty-four years. The condition, however, has been reported as occurring in infants and in old persons.

Parsons classifies tuberculous lesions of the iris as follows, first, the miliary tubercle, second, confluent or conglomerate tubercles, third, tuberculous iritis. The last type, not always capable of being clinically distinguished from other forms of chronic iritis, frequently reveals a tubercle system or the presence of bacilli in the tissues when sections of the diseased area are examined microscopically. However, in many cases when no tuberculous changes are found in the tissues and when inoculation into animals proves negative, the iritis must be attributed to toxins. The tubercle bacilli in some cases are present in such small numbers that they are overlooked.

In the first type the iris lesions are seen as small elevations of yellowish or grayish character, occurring in both zones of the iris. If the disease is progressive the elevations become confluent and change to a grayish-red color. Later the cornea and ciliary body become involved and perforation of the globe near the limbus is not uncommon.

The course of this type of tuberculosis of the iris is extremely variable. Some cases are chronic in nature throughout, others are of mild character for a time and suddenly become acute, resulting in rapid destruction of the eye or even in meningitis, while other cases are acute from the onset.

Stock, from experiments on rabbits, found that the first symptoms noted in the iris, after the injection of diluted mixtures of tubercle bacilli into the blood, was a general thickening of the iris tissue without unusual thickening of the blood vessels. Three or four days later small grayish masses appeared in the iris tissue. Some animals

showed a generalized hyperemia of the iris with the formation of new vessels and a generalized appearance of granulation tissue. The iris might also be so intensely infiltrated that solitary nodules cannot be detected. Stock and Tooke contend that a predilection of a site for the tubercle does not exist and that it may appear at the pupillary margin, at the middle of the iris, or at the filtration angle, and clinically it is often associated with involvement of the cornea and ciliary body. The confluent or conglomerate tubercle (Parsons) resembles a tumor of the iris. It is yellowish-white in color and often small nodules are seen surrounding the large mass. This growth remains confined to the anterior segment of the globe and the supra-choroidal space is only rarely involved in the process. In this class perforation of the eyeball most often occurs at the angle of the anterior chamber before involvement of the choroid or vitreous takes place. (For further details of tuberculosis of the iris consult Vol. IX, p. 6640.)

Stock and Verhoeff's experiments, as well as clinical experience, place tuberculosis as a frequent etiological factor in cyclitis. When the cause of cyclitis is obscure tests should be used to determine the presence of tuberculosis.

The ciliary body is a structure which is frequently involved in granulomatous affections and, probably, is more often the starting point of tuberculosis of the eye than published records would lead one to believe. Lagrange noted that this condition often results in perforation of the globe.

The early differential diagnosis of *tuberculosis of the ciliary body* is difficult because the symptoms are the same as those of cyclitis due to other causes. Involvement of the iris and choroid are frequently associated with the cyclitis, and when present the characteristic changes of tuberculosis are noted in these structures. This condition may be confounded with tubercular syphilide. Treatment with mercury will differentiate the two. (Consult Vol. V, p. 3626.)

Choroidal tuberculosis is fully discussed in Vol. 3, page 2159, and only a few additional points are mentioned here. The first case of this condition was reported by Manz in 1858 and he submitted two additional reports in 1863. Bauch reported a case in 1866. In 1867 Cohenheim's investigations proved that it was more frequent than had been formerly supposed. Since then other observers have reported many cases.

Jäger was the first to clearly describe the disseminated variety as small ill-defined patches of yellowish or pale-reddish color which are seen in the fundus. These patches increase in diameter, but rarely attain a size larger than one-third that of the optic disc.

In a study of the text books it is startling to find that *tuberculosis of the retina* is only mentioned and the symptoms of this important disease are not described. The reason for this is that it has only been in recent years that the true nature of this condition has been recognized and, to learn the nature of the symptom-complex which accompanies tuberculosis in this location, one is compelled to consult the literature on the subject.

Retinal tuberculosis occurs most often as a vasculitis or a peri-vasculitis of the retinal vessels which manifests itself most often, in the beginning, by a collection of white infiltrates which surround the retinal vessels. The veins are most frequently attacked. The condition, at this stage, is probably a perivaseculitis. The calibre of the vessels is not materially altered in the beginning but as the condition progresses the vessel walls become involved in a true vasculitis and the calibre of the vessels becomes altered. Varicosities and constrictions are noted in different portions of the same vessel. If the exudation is slight and the vitreous is clear at this stage, the patient may not suffer from alteration in the visual acuity. In fact he may not realize the existence of any disease in his eyes, unless some other portion of the eye is involved in conjunction with the retina. In one of the author's cases corneal involvement in the beginning of the disease caused sufficient lachrymation and photophobia to call the patient's attention to his eyes. Upon ophthalmoscopic examination early signs of tuberculosis of the retinal vessels were discovered. With the absence of visual disturbance or other disagreeable symptoms vascular tuberculosis might go undetected until the hemorrhagic stage of the disease is reached.

As the vasculitis progresses the vascular walls become thinned and finally hemorrhages occur which vary from comparatively small ones, confined to the retina, to massive hemorrhages which either push the vitreous forward or burst into it. It is at this stage that the patient is likely to first consult the oculist. The hemorrhages might be confined to the retina throughout the course of the disease. In these milder types the blood is absorbed and often no permanent trace of them is left. In the massive type the vision is lost or very markedly diminished at the time of the hemorrhage and, as a rule, is permanently impaired due to the replacement of the hemorrhagic exudate, at least in part, by connective tissue in the form of retinitis proliferans.

Where recurrent hemorrhages occur into the retina and vitreous with improvement of vision between the attacks the presence of tuberculosis should be suspected. This is especially true if the condition is found in young persons.

In another form of retinal tuberculosis the disease is confined to the retinal structures and the macula is most often the seat of greatest involvement. The lesions are small, white areas in the retina which resemble those that are found in albuminuric retinitis. If they are located in the macula the vision is impaired. These lesions often clear up entirely and leave no scars visible with the ophthalmoscope. Very frequently the optic nerve is involved in conjunction with the retinal process.

Tuberculous masses may develop in the retina and be mistaken for tumors. These are usually associated with tuberculosis of the nerve or ciliary body and are only diagnosed by the microscope after enucleation of the eye.

In the sheaths and septa of the *optic nerve miliary tubercles* are not infrequently found. They occur secondary to extension from either the eye, the orbit, or the brain. The disease may occur as a single small tubercle, as several small miliary tubercles, or as one large tuberculous mass. The lesion may be located any place along the course of the nerve, either intra-ocular or retro-bulbar, and may be confined to one type of tissue or involve both the coverings and the nerve fibres. The symptoms vary with the amount of involvement but in general are those of optic neuritis due to other conditions. Early enucleation is advisable if the involvement is extensive or if the condition fails to yield to treatment.

Episcleritis and scleritis in a certain percentage of cases has, as its cause, tuberculosis. Verhoeff has proved this by experiments with the dead bacilli which he injected into the anterior chamber and the vitreous. He found from this experiment that a kerato-scleritis and scleritis developed in several of the animals. The sclera is often involved with tuberculosis of the uveal tract, metastasis taking place through the filtration angle, and the sclera of the anterior portion of the globe is first attacked. Episcleral tuberculosis and scleral tuberculosis give the symptoms of episcleritis and scleritis in general. They are chronic in their nature and have a tendency to recur. The treatment, after the cause has been definitely determined to be tuberculosis, is that of tuberculosis as discussed later in this section. See **Scleritis** in the *Encyclopedia*.

In the *diagnosis of tuberculosis of the eye* ophthalmologists have been too prone to regard this condition as outside their special province. This has given a false point of view from which errors have developed. Many still hesitate to consider eye lesions tuberculous in character unless tuberculosis is at the same time evident in some other portion of the body, as in the lungs or lymph glands, or unless there

are general symptoms accompanied by loss of weight and increased temperature. Tuberculosis may be present in the eye and latent in some part of the body without any of the foregoing symptoms being present.

As stated earlier, the majority of cases of eye tuberculosis are secondary to tuberculosis in some other portion of the body. These primary foci are not necessarily very active and may not produce constitutional symptoms, but at the same time may be capable of discharging a few attenuated organisms into the general circulation which may find favorable surroundings for their growth in the eye. There they may produce an active ocular tuberculosis. It is also probable that the toxic products of these organisms may have some influence in the production of lesions in certain tissues of the eye. Many persons affected with tuberculosis of the eye have the appearance of being in good general health and, unless a thorough search is made, the primary focus may be overlooked.

The demonstration of the tubercle bacillus in lesions removes all doubt of the etiology of the process but in chronic lesions the organism is not always found. Whenever feasible, however, sections of tissue from the involved area should be removed, carefully placed in fixing solution, and then sent to the pathologist for microscopic examination. In some cases tissue cannot be removed and one has to resort to careful microscopic examination of scrapings, obtained from the diseased area. When it is possible animal inoculation should be employed. Small sections of diseased tissue should be removed under the most aseptic conditions and inoculated into the peritoneum or eye of guinea pigs. The animals are then watched for several weeks for signs of tuberculosis. By this method, if the condition is tuberculous, positive results will be noted in many cases where the bacillus cannot be found in secretions and scrapings from the diseased area. Some observers have removed the aqueous from the anterior segment of the eye and injected it into the eyes or into the peritoneal cavity of animals and have been able to make a positive diagnosis by this means. Poyales calls attention to the fact that exposure of the guinea pig to X-rays increases its susceptibility to the tubercle bacillus. This can shorten the time required for the bacteriologic test by inoculation. It renders the method more sensitive, which is a matter of importance where the bacilli are scarce and attenuated, as they often are in ocular lesions. Cultures should be tried. They are not as reliable as animal inoculations and take a much longer time to get positive results.

If tuberculosis of the eye is suspected, because of the presence of obscure and suggestive symptoms, the observer should attempt to definitely determine whether it is of primary or secondary origin. In

either event, but more especially if the condition is secondary, one should examine the subject, or have him examined by a competent internist, to determine whether tuberculosis exists elsewhere in the body. Too frequently the observer concludes that the case is one of tuberculosis of the eye and resorts to the diagnostic use of tuberculin without first having made a careful physical examination of the patient. This examination should be complete enough to exclude other possible causes of inflammation of the eye, such as foci of infection in teeth, tonsils, prostate, etc.

It stands to reason that there will be great danger in the use of diagnostic doses of tuberculin if the patient has a cavity in the lungs, with tubercle bacilli in the sputum, or shows an active tuberculous process in the joints, vertebrae, or elsewhere.

If active pulmonary, lymphatic, or other tuberculosis is not found by physical examination some forms of tuberculin may be used as an aid in the diagnosis of tuberculosis of the eye.

The various methods which have been employed for this purpose are Calmette's ophthalmo-tuberculin reaction, von Pirquet's reaction, the Moro test, and the Koch subcutaneous tuberculin test. The Calmette test is performed by instilling one drop of a 1 per cent. aqueous solution of specially prepared old tuberculin, into the conjunctival sac. In a few hours if the reaction is positive a varying degree of hyperemia which reaches its maximum in 24 hours, appears with some lachrymation and signs of irritation. If the reaction is severe edema and even corneal ulceration may be produced. Positive results are frequently noted in cases which are not active, and, for this reason, the test is not very reliable. Because of the danger of serious reactions resulting in damage to the eye this method is not in popular use. (For further details see Vol. II, p. 1361, also under **Tuberculin**.)

The von Pirquet skin test is as simple as well as a harmless method. Unfortunately it is of little value because it is so sensitive that a positive reaction is usually found. However, in young children a positive reaction is of diagnostic importance. In adults a negative reaction with other negative physical findings, would tend to make the observer doubt the presence of tuberculosis as an etiologic factor in eye disease. This is especially true in the secondary type for here the bacilli or their products have been carried to the eye by the blood or lymph and have produced changes there. The subject would, under these circumstances, be sensitive to tuberculin applied to the skin.

The technique of the von Pirquet test is as follows: The inner surface of the forearm is cleaned with alcohol or ether and a drop of pure tuberculin is applied to the skin. An abrasion is then made with a

suitable instrument in the skin about two inches away from the place where the tuberculin has been applied. A second abrasion is then made with the same instrument over the tuberculin. The tuberculin is rubbed into the skin while the second abrasion is being made. In abrading the skin care should be taken not to go too deep and cause bleeding. Only the superficial layer of skin should be scraped away to open the lymph spaces to permit the absorption of the tuberculin. The tuberculin is allowed to dry and no dressing is applied. If the test proves positive the control, i. e., the abrasion to which the tuberculin has not been applied, appears healed or shows a slight scab, while the other abrasion is inflamed and is a slightly elevated, red papule. If the test is negative both abrasions have the same appearance. As a rule the reaction makes its appearance within twelve or twenty-four hours but it may be seen rather prematurely in some cases, in four to six hours, or it may be late in appearing. A delay of a week has been observed in rare cases. Quite often the first test results in a negative outcome and a second test should be made about a week later which will frequently result in a positive reaction.

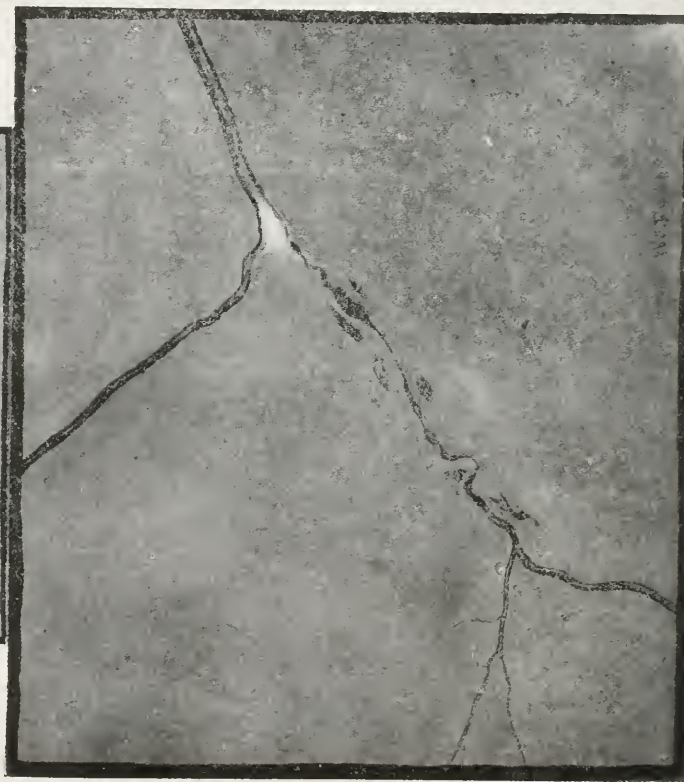
The Moro test is performed by gently rubbing a dehydrated lanolin ointment, of 50 per cent. old tuberculin, into the chest or abdomen over an area of 5 cm. The surface is left uncovered for ten or fifteen minutes. In a period of from three hours to three days after the application of the ointment an erythema results in positive cases. The reaction is divided into three grades, viz., first, mild; second, moderately strong; and third, severe. The Moro test is neither as sensitive nor as reliable as the von Pirquet test.

The subcutaneous use of tuberculin is the test preferred as a diagnostic agent by most observers. In the profession at large this method has many enthusiastic advocates and a few bitter opponents. Since von Hippel advocated its use as a diagnostic measure in lesions of the eye the test has found wide application in ophthalmology. By its advocates it is used as a diagnostic test in doubtful cases of tuberculosis. It is not only employed to determine whether the subject has ever been infected by the tubercle bacilli but also to learn whether the tuberculosis is active. The subcutaneous injection of tuberculin is also used to ascertain whether a focal reaction will occur in the suspected eye lesion. If any marked tuberculous activity is found to be present in the body the subcutaneous injection of tuberculin as a diagnostic agent will be of no value and might result disastrously by greatly impairing the patient's general health. Under such circumstances one must make the diagnosis of the eye lesion from the general appearance and clinical findings in the eye.

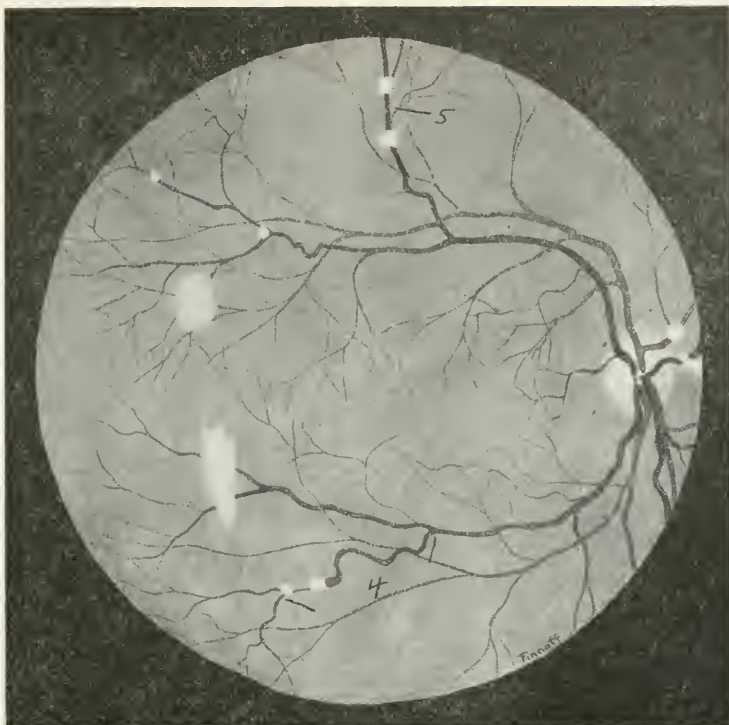
If all efforts fail in finding tuberculous activity in the lungs or elsewhere, the subject's temperature should be taken every two or three hours for a period of at least twenty-four hours. The results should be carefully recorded. If the patient's temperature has been normal during the twenty-four hour period, 0.1 mg. of old tuberculin is injected subcutaneously. As the reaction may take place in eight or nine hours, the best time to inject the tuberculin is early in the morning or at night, just before the patient retires, so that the reaction will not occur while he is asleep and thus escape being observed. In the case of a positive general reaction the temperature rises. If no rise in temperature is noted in forty-eight hours a second injection is made with 1 mg. of tuberculin. In the event that the second test proves negative after forty-eight hours 3 mg. is used and, in another forty-eight hours, if no reaction occurs, 5 mg. is given. Most observers assure us that if no reaction is noted after this series of injections tuberculosis is absent. However, a few advise that the last dose be 10 mg. In children smaller doses are employed. The injections are employed at forty-eight hour intervals to avoid the occurrence of anaphylaxis.

Positive reactions usually occur between ten and twelve hours. Occasionally it is noted as early as six and as late as forty-eight hours. Three types of reaction occur, viz: constitutional, local, and focal. The constitutional symptoms are manifested by increase in the temperature to between 100° and 102° and, occasionally, in severe reactions it may reach 104° . Headache, backache, pains in the joints, *malaise*, weakness and in some cases nausea and vomiting are noted. In a few instances marked prostration may occur. In twenty-four to forty-eight hours all symptoms usually pass away. Locally, at the site of the injection, there will be tenderness and sometimes pain, redness, a swelling which varies in size from 1 cm. to 10 or 12 cm., and occasionally the regional lymphatics are slightly enlarged. The focal reaction should be carefully watched for. The appearance of this condition will depend upon the location and nature of the eye lesion. In most instances it is to be avoided if possible. Increased injection, fresh exudation, and hemorrhages are among the changes which have been observed. When a focal reaction is severe and occurs in the cornea or retina some permanent impairment of vision may result. If a positive focal reaction is noted the diagnosis of tuberculosis of the eye is established. It is equally true that a general reaction with no focal reaction only gives us a probable hint regarding the etiology of the eye lesion.

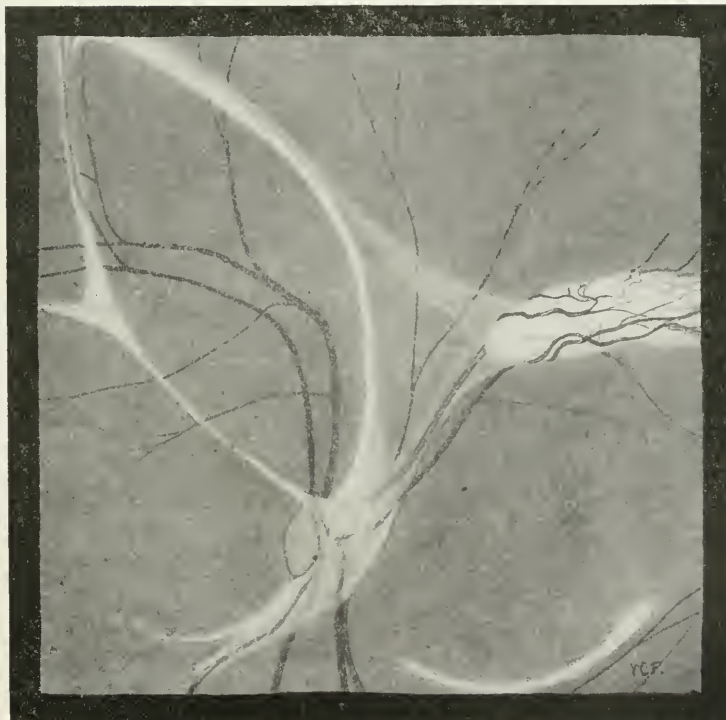
At present the reports on complement fixation for tuberculosis are



Tuberculosis of the Retinal Vessels. (Finoff.)



Tuberculosis of the Retinal Vessels. 4 and 5 indicate portions shown in detail on preceding plate. (Finoff.)



Tuberculosis of the Retina. Bands of retinitis proliferans as seen 2½ years after the onset of the disease. (Finoff.)

so conflicting that the test is not reliable. Further development might make it of value in the future.

It should be the ophthalmologist's aim in all cases to determine during the incipient stage of the disease, whether the condition found in the eye is due to tuberculosis. If it is so decided it becomes his duty to employ every known means to effect a cure. It should equally be his desire, in cases where every effort at treatment has failed and enucleation becomes necessary, to carefully fix and examine the eye, or have it examined, microscopically. When patients, who have suspected tuberculosis of the eye, die of intercurrent disease the ophthalmologist should try to obtain the eyes for microscopic study as soon as possible after death. It is only by such study that a more exact knowledge of the clinical findings of tuberculosis of the eye can be obtained.

In the *treatment of ocular tuberculosis* many things must be considered and the greatest care and sound judgment is required to obtain the desired result. The first and most important thing for the ophthalmologist to determine is the full extent of the tuberculosis generally, as well as locally, in the eye. The X-ray will frequently be of great assistance in throwing light on obscure cases. It is not until after the extent and activity of the tuberculosis have been fully investigated that an intelligent and effective course of treatment may be outlined for the patient. The prognosis, too, will depend, to a great extent, on the findings. If there is much activity elsewhere in the body the aid of one skilled in the treatment of general tuberculosis should be solicited by the ophthalmologist in carrying out the treatment. It must be remembered that the patient as well as the eye must be considered. If, however, the tuberculosis is apparently primarily situated in the eye and no other organs are found to be involved after careful and systematic search, the responsibility of the treatment would naturally fall upon the ophthalmologist.

If the general condition of the patient is bad, because of the presence of active tuberculosis in the lungs or other organs, rest, under the most favorable surroundings and climatic conditions with good and nourishing food, should be the first step in the treatment. A well regulated sanitarium fills these requirements and is the most satisfactory place for these cases. Here tuberculin, which might have been indicated had the eye condition existed alone, would be absolutely contraindicated, excepting in the most minute doses and with great caution because of the danger of increasing the general activity and materially undermining the patient's general health. In these difficult and discouraging cases the only course of treatment for the eye, other

than that outlined above, is symptomatic and local, and will depend upon the location and extent of the ocular process.

The general condition of the subject is very important and an effort must be made to make it clear to the patient that this phase of treatment is just as essential as local eye treatment.

When it is seen that the patient's hygienic conditions are satisfactory, and general treatment is put into effect, the advisability of using tuberculin as a therapeutic measure may be considered.

At the present time there is much discussion regarding the value of tuberculin as a curative measure, and ophthalmologists are divided into two schools on this subject. The larger school believes that in tuberculin we have an agent which has, if the product is properly given, a curative value in cases of tuberculosis of the eye. The smaller group believes that it is of no value and often harmful.

It is true that tuberculin is not a specific remedy for tuberculosis, but if the majority of writers on this subject of ocular tuberculosis have been fair in their conclusions, and not biased in their convictions, we can reasonably believe that tuberculin in intelligent hands is a valuable remedy in the treatment of chronic tuberculosis of the eye. It certainly is not indicated in the acute types which occur in a disseminate miliary tuberculosis or in the choroidal type associated with tuberculous meningitis.

Most observers prefer new tuberculin (T. R.) or the bacillus emulsion (B. E.), although other preparations have been used and reported to have been equally successful in curing or ameliorating the disease.

As the physiological action of tuberculin differs in different preparations and, even in the same variety of tuberculin made by different pharmaceutical houses, an iron-clad rule in dosage and administration cannot be laid down. It is wisest to start with very minute doses and gradually increase their strength. The sensibility varies also in different persons. Some react to smaller doses than others, making it necessary to study each individual case and regulate the dosage accordingly.

In eye tuberculosis the rule followed in the administration of tuberculin is to keep the dose just below the strength which will produce a focal or general reaction. Focal reactions are noted by an aggravation of the symptoms, viz., increased redness, increased exudation, hemorrhages or lowering of vision. After each dose is administered the patient's temperature should be noted for 24 to 48 hours and the eye examined externally and with the ophthalmoscope. Some advise securing a slight and evanescent reaction. This should obviously not

be the case in vasculitis of the retinal vessels because of the great danger of hemorrhages which so frequently are replaced by bands of scar tissue. Von Hippel advised giving 1:500 mg. as the initial dose. Serious reactions have resulted from such a large dose and at present most observers start with much smaller, usually as low as 1:10,000 mg., and gradually increase to just within the point of reaction. If the patient reacts the dose is diminished. If previous doses were given, the amount following the reaction should be of the strength which is known to have not caused focal or general changes in previous injections.

The injections should be given at regular intervals. Some advise giving them every four days while others recommend intervals of seven or ten days. At the Knapp Memorial Hospital the initial dose is 1:10,000 mg., and an increase of 1:10,000 mg. with each subsequent dose at four day intervals, until 1:1000 mg. is reached. Then 1:1000 mg. is added to each dose at the same interval until 1:100 mg. is given, then the doses are given at weekly intervals adding 1:100 mg. until a dose of 1:10 mg. is reached. The interval is then lengthened to two weeks and 1:10 mg. is added to each dose. When 1 mg. is reached the interval is lengthened to once a month.

The usual interval between injections is a week. It is not advisable to follow any routine method in the size of the dose because of the great variations of individual susceptibility. It is preferable to increase the dose as much as possible without producing reaction.

The treatment should be continued for several months after the patient appears cured. If no symptoms occur for four or five months the treatment may be discontinued. If relapse occurs the treatment should be resumed cautiously and carried on in the same manner as previously.

Radium has been used in the treatment of tuberculosis and has been reported as effecting cures. Pissarello reported the favorable action of radium in two cases of conjunctival tuberculosis in which the diagnosis was confirmed by bacteriological and experimental tests. In one case the application was continued over five weeks. Three and one half hours in the aggregate caused complete cure. In the other case treatment was continued two months, a total of five hours, and some of the vegetations were excised.

Some have found the Finsen light of value in the treatment of conjunctival tuberculosis and lupus. Lundsgaard had nineteen cases of conjunctival tuberculosis which were cured by this means as were most of his twenty-nine cases of lupus which involved the skin.

Libby, in addition to the systematic use of tuberculin in his case

of conjunctival tuberculosis, exposed the conjunctiva to sunlight. The first exposures were ten seconds but in a short time they were lengthened to sixty-three seconds repeated from two to six times a day. On two occasions the conjunctiva became inflamed and the treatments were discontinued for a week and then resumed. The final result was satisfactory.

The X-ray has been used in the treatment of tuberculosis of the eye but the results have not been very encouraging. It can, however, be used in conjunction with the treatment outlined above and may in some cases prove to be of value.

Kerry (*Ophthalmology*, VI, p. 368) treated five cases of tuberculosis about the eyes with favorable results in four cases. He injected a mixture containing 4 grains of iodoform in a 20 per cent. mixture with paraffin oil, containing 1 per cent. of carbolic acid, hypodermatically once or twice a week. He also injected iodoform in the anterior chamber in a case of kerato-iritis, but in this case the result was not satisfactory.

The advisability of excision of tuberculous areas continually suggests itself in the treatment of tuberculosis. In tuberculosis outside the globe this might be of value but when the involvement is intraocular surgical interference is dangerous and sometimes fatal. Von Hippel would not do an iridectomy until a tuberculous eye had been quiet for two years. During the active stage there is danger of dissemination of the bacilli during the operation which might result in a tuberculous meningitis or general miliary tuberculosis. If the globe is extensively involved in an acute tuberculosis and caseation results, enucleation is the advisable procedure because the tuberculous area is retained within the globe and dissemination does not take place. In acute involvement of the optic nerve enucleation is also advisable because of the danger of extension through the subvaginal space to the membrane of the brain.—(W. C. F.)

Tuberculosis. See **Scrofuloderma**.

Tuberculous diseases of the eye. See **Tuberculosis of the eye**.

Tubes, Collapsible. COLLAPSIBLES. The need of some improvement over the ancient and dirty habit of dispensing eye salves in small pots in which the contents are, during use, continually exposed to every source of contamination must appeal to the careful surgeon. This end is met by the employment of collapsible tubes. These are generally made of pure tin and with them is sometimes provided a glass tube or camel-hair brush for applying the salve to the eye.

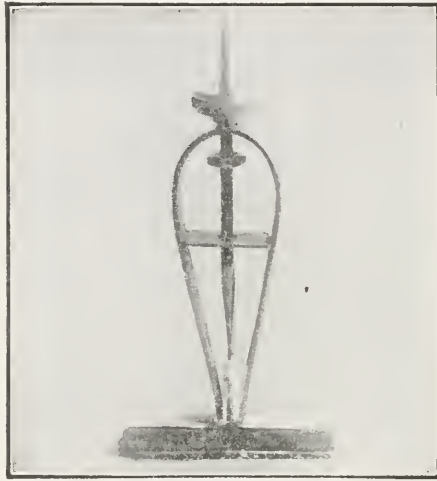
A small quantity—from 2 to 8 grammes, or $\frac{1}{2}$ to 4 drams—of the ointment is prescribed and ordered to be supplied to the patient, while

a larger amount is put up for the surgeon. In this way most salves, protected from the air and other sources of sepsis, keep fresh and unpolluted indefinitely. The required amount needed for daily applications can be squeezed out at will, the small cap returned to its place, and the tube is ready for the next occasion.

Tubular epithelioma. Cylindroma.

Tubular vision. See **Telescopic vision.**

Tucker. TENDON TUCKER. See p. 8229, Vol. XI of this *Encyclopedia*; also under **Strabismus**. A recently invented instrument for rendering the tucking operation easier and more exact, and which can be



Bishop's Tendon Tucker

used to measure the amount of advancement required is described by Wesley Bishop. (*Pract. Med. Series. Eye*, 1919). The performance of "tucking" under general anesthesia must of necessity entail more or less haphazard guesswork as to the result. To procure parallelism, the coöperation of the patient becomes an important factor; and to this end the operation should be performed under local anesthesia. It is here that we have met with our greatest trial, the pain caused by the traction on the muscle during the formation of the tuck being sufficient to interfere seriously with the patient's attempt at fixation. Again: The placing of sutures, with the muscle tightly stretched against the eyeball, is not without difficulties, especially when using certain forms of tucker.

The writer has found the instrument illustrated useful. Briefly it consists of a double standard, each leg of which terminates in a

cross-bar base; to form the support for a flat hook, which operates between the standards, being raised or lowered by means of a thumb-screw.

A few drops of 4 per cent. cocain adrenalin solution are instilled at one minute intervals. As usual the conjunctival and capsular flaps are dissected back, exposing fully the muscle to be shortened, and upon this a drop of 10-per cent. cocain solution is now placed.

The instrument is held perpendicular to the muscle, with the cross-bars forming its base squarely at right angles to the edge of the muscle, the hoop being under it. To form the tuck the hook is raised by means of the thumbscrew, carrying upon it the muscle, thus raising a loop of muscle between the two standards.

With the patient looking straight ahead, the hook is raised until parallelism of the eyes is obtained, then a 00 pyoktanin catgut (20-day), suture is passed through each side of the tuck at its base in the angle formed by the upright of each standard with its cross-bar base. The width of the standards separates the sutures and incidentally protects the central blood supply of the muscle. By reversing the thumbscrew the hoop is now lowered and the instrument removed, the flaps are then sutured in place and the toilet of the wound completed.

The formation of a "tuck" with no complaint from the patient is due to the fact that with this instrument the traction on the muscle is in one direction; whereas with other instruments this traction is in two opposite directions, thus causing more pressure on the muscle fibers.

The placing of sutures is easy and accurate, as the upright standards offer no obstruction and the angle formed by each with its cross-bar base provides the determining point of suture.

Tucking operations. See pp. 8220 and 8229, Vol. XI of this *Encyclopedia*; also **Tucker**.

Tucutuco (*Ctenomys brasiliensis*), Eyes of the. In his journal kept during the Voyage of the Beagle, Charles Darwin describes this curious animal as a Gnawer, with the habits of a mole. It is, he says, extremely numerous in some parts of South America, but is difficult to be procured, and never, he believes, comes out of the ground. "It throws up at the mouth of its burrows hillocks of earth like those of the mole but smaller. Considerable tracts of country are so completely undermined by these animals, that horses in passing over, sink above their fetlocks. The tucutucos appear, to a certain degree, to be gregarious: the man who procured the specimens caught six together, and he said this was a common occurrence. They are noc-

turnal in their habits; and their principal food is the roots of plants, which are the object of their extensive and superficial burrows. This animal is universally known by a very peculiar noise which it makes when beneath the ground. A person the first time he hears it, is much surprised; for it is not easy to tell whence it comes, nor is it possible to guess what kind of creature utters it. The noise consists in a short, but not rough, nasal grunt, which is monotonously repeated about four times in quick succession: the name Tucutueo is given in imitation of the sound. Where this animal is abundant, it may be heard at all times of the day, and sometimes directly beneath one's feet. Many are invariably found *blind*." A specimen which Darwin preserved in spirits was in this state. Some authorities consider the blindness to result from inflammation of the nictitating membrane. When Darwin placed his finger within half an inch of its head during life not the slightest notice was taken: it made its way, however, about the room nearly as well as the others.

"Considering the strictly subterranean habits of the tucutueo, the blindness, though so common, cannot be a very serious evil; yet it appears strange that any animal should possess an organ frequently subject to be injured. Lamarek would have been delighted with this fact, had he known it, when speculating (probably with more truth than usual with him) on the *gradually-acquired blindness* of the Aspalax, a Gnawer living under ground, and of Proteus, a reptile living in dark caverns filled with water; in both of which animals the eye is in an almost rudimentary state, and is covered by tendinous membrane and skin. In the common *mole* the eye is extraordinarily small but perfect, though many anatomists doubt whether it is connected with the true optic nerve; its vision must certainly be imperfect, though probably useful to the animal when it leaves its burrow. In the tucutueo, which I believe never comes to the surface of the ground, the eye is rather larger, but often rendered blind and useless, though without apparently causing any inconvenience to the animal; no doubt Lamarek would have said that the tucutueo is now passing into the state of the Aspalax and Proteus." See **Blind mammals**.

Tulase. See **Tuberculin**.

Tularensis conjunctivitis. See p. 3157, Vol. V of this *Encyclopedia*.

Tumor, Brain. See **Brain tumor**, p. 1273, Vol. II of this *Encyclopedia*.

Tumors, Cerebral. Uhthoff recites ophthalmic experiences and considerations on the surgery of cerebral tumors and tower skull. (The Bowman Lecture, *Trans. Ophthal. Soc. U. K.*, 1914, Vol. XXXIV.) His experiences refer to ophthalmic diagnosis in its relation to opera-

tions on tumors of the cerebrum and cerebellum, and there are special sections of this lecture devoted to pituitary tumors and to tower skull.

Uthoff believes that the ophthalmoscopic picture of typical choked disc indicates in the great majority of cases brain tumor. Brain tumor was present in 74.6 per cent. of the cases of bilateral choked disc. It must be remembered, however, that, although rare (0.3 per cent.), congenital pseudoneuritis may appear as choked disc, accompanied by violent cerebral symptoms. Such symptoms may prove, e. g., to be hysterical. In the differential diagnosis as to whether the choked disc is congenital or acquired, one must take into consideration the presence or absence of hemorrhages, etc., and recollect the appearance of hyaline bodies in the papilla. Bilateral "non-prominent" optic neuritis was observed by the author in only 6.5 per cent. of brain tumors—that is, exclusive of those cases where choked disc eventually came on. While bilateral choked disc and optic neuritis is the rule in intracranial tumors, these conditions are of little use in localization. From the accompanying symptoms (hemianopia, hemiplegia, etc.) it is often possible to draw localizing conclusions.

The author discusses *fully* the question of the diagnostic value and occurrence of unilateral choked disc, optic neuritis, and optic atrophy in intracranial diseases. It is here only possible to give a few of the points which he makes. In cases of brain tumor, unilateral choked disc was observed in 4.1 per cent. (66 per cent. ipsilateral). Non-prominent optic neuritis was very rarely seen in brain tumor; it was never seen at all in brain abscess, hydrocephalus, or tower skull; it occurred in a considerable percentage of cases of cerebral syphilis.

Uthoff thinks that too much has been made by some surgeons of homolaterality of the lesion as a symptom. "It is by no means always possible in tumor of the cerebrum to draw the conclusion from unilateral choked disc that the seat of the tumor is situated on the same side; only in 56 per cent. of the cases in question was the brain lesion on the same side as the choked disc.

In tumors of the cerebellum the statistics in question show that the tumor is just as often on the same side as the choked disc as on the opposite side.

Bilateral choked disc or optic neuritis, but with more prominence in one eye, was found to correspond with a situation of the cerebral tumor on the same side in 73 per cent. of cases.

A tumor in the anterior parts of the cerebrum seems more likely to produce a unilateral papillitis than one situated posteriorly. This is to be explained by greater pressure on the optic nerve on the side of the tumor. "More pronounced retinal hemorrhage on one side ac-

accompanied by unilateral choked disc, the result of cerebral tumor, does not justify the conclusion that the seat of the tumor is on the same side (Horsley); in our material the opposite was nearly as often the case."

Brain abscess is next referred to. For the localization of this, unilateral choked disc is of greater importance than in tumor. It cannot be set down as an invariable rule that unilateral choked disc must be on the same side as cerebral abscess, but this is much oftener the case than in brain tumor. The same thing holds for bilateral choked disc with greater prominence on one side. With regard to non-prominent optic neuritis in abscess, the following statement is made—"On the whole, unilateral optic neuritis or hyperemia of the papilla and unilateral greater development of the optic neuritis, indicate a situation of the abscess on the same side."

The author is very emphatic as to the urgency of operation in cases of brain abscess which show choked disc or optic neuritis. In 80 per cent. of such cases, the abscess is connected with the ear.

Uhthoff next deals with the clinical symptoms of choked disc. As is well known, the typical picture of choked disc can exist with complete preservation of sight. In the author's series, this occurred in 29 per cent. of his cases and of these some showed no considerable disturbance of vision for over a year. But if the sight does become manifestly defective, the loss generally progresses rapidly if surgical intervention be not undertaken. It is therefore dangerous to postpone operation too long. A postponement of operation is justifiable if the sight and visual field can be kept under observation and while the vision is intact and the field full. The possibility of spontaneous recovery must be remembered. This took place in about 5 per cent. of the cases in which choked disc was accompanied by all the symptoms that indicate brain tumor.

The author goes at length into the various disturbances of the field of vision, giving percentages. Enlargement of the blind-spot was an almost constant anomaly of the field in choked disc, yet it may be absent in quite recent cases. If a further restriction of the field took place, this occurred mostly under the picture of a peripheral, more or less concentric, contraction, so that this form of deterioration of the field of vision is rather characteristic of choked disc. Homonymous hemianopia was always regarded as having a direct localizing value. On the whole, says Uhthoff, homonymous hemianopia without macular diverticulum, indicates a basal lesion, or at least a localization of the tumor in front of the entrance into the occipital lobe of the optic radiation of Gratiolet.

The author says that he does not quite agree with the views of the shifting and interlacing of the color fields held by such observers as Cushing, Sachs, and Bordley. In cases of intracranial disease, when sight is still good and the fundus normal, he does not think it right from such an anomaly of the color sensation to draw the conclusion that choked disc will ensue.

Disturbances of the ocular muscles, Uhthoff says, are of far less importance than intra-ocular changes in the diagnosis and localization of brain tumor, and as a guide to operation.

As to operations on brain tumors, Uhthoff discusses lumbar puncture, Neisser-Pollack brain puncture, corpus callosum puncture (Anton and v. Bramann), palliative trephining, and extirpation of brain tumor. Uhthoff regards the second and third as less dangerous than the first, and considers the second to be comparatively free from danger. In about 25 per cent. of the cases this operation (brain puncture) proved advantageous in that the anatomical examination of the thin cylinder of cerebral substance, obtained during the operation, decided the nature of the tumor. It may properly be performed as a first intervention, since it is relatively free from danger, affords relief to the symptoms, and furnishes diagnostic indications. In certain cases which turn out not to be brain tumor but, say, hydrocephalus internus, this simple decompressive operation may be of lasting benefit, and may even effect a cure. Of corpus callosum puncture the author has not had much personal experience, but refers to the work of Anton and v. Bramann. If this operation has no effect upon the choked disc, a further operation can be undertaken under more favorable conditions of intracranial pressure. He (Uhthoff) considers it the least dangerous procedure next to the Neisser-Pollack brain puncture. Palliative trephining and extirpation of the tumor are discussed statistically.

Tumors of the eye. NEOPLASMS OR NEW GROWTHS IN AND OF THE OCULAR APPARATUS. The size and importance of this section demand a *Table of Contents*, which is given as follows:

Introduction—Historical—Pathology and Etiology of Tumors in General—Definition of Tumor—Classification of Tumors—Pseudotumor—Metastasis of Tumors—Literature and Bibliography.

TUMORS OF THE EYELIDS.

Adenoma—Carcinoma—Angioma—Hemangioma—Blastomyces of the Eyelid—Carcinoma of the Meibomian Glands—Epithelioma—Rodent Ulcer—Jacob's Ulcer—Treatment of Epitheliomata—Chalazion—

Colloid Tumor of the Eyelid—Cornu Cutaneum—Cylindroma of the Lid—Cysts of the Lid—Cysts of the Meibomian Glands—Cystoma—Dermoids of the Eyelid—Endothelioma—Elephantiasis of the Eyelid—Fibroma—Fibroma Molluscum—Neurofibroma—Recklinghausen's Fibroma—Granuloma—Gumma of the Lid—Keloid of the Lid—Leiomyoma—Lipoma—Lymphoma of the Eyelid—Plasmocytoma—Lymphangioma of the Lid—Milium—Molluscum Contagiosum—Nævus Pigmentosus or Pigmented Mole—Nævus Vasculosus—Neuroma of the Lid—Plexiform Neuroma—Ganglioneuroma—Neurofibroma—Papilloma—Perithelioma—Rhabdomyoma of the Eyelid—Sarcoma of the Eyelids—Angiosarcoma—Mixed Sarcoma—Cylindroma—Tubular Cancer—Alveolar Epithelioma—Endothelioma of the Lid—Peritheliomata of the Eyelid—Sarcoid of the Lid—Verruca or Wart—Papilloma—Xanthelasma—Xanthoma Palpebrarum—Xeroderma Pigmentosum—Melanosis Lenticularis—Kaposi's Disease.

TUMORS OF THE CARUNCLE AND PLICA SEMILUNARIS.

Classification—Adenoma—Spiradenoma Papilliferum Cysticum—Carcinoma of the Caruncle—Pavement Epithelioma—Cysts of the Caruncle—Dermoid—Epithelioma—Fibroma—Hyaline, Colloid and Amyloid Tumors of the Caruncle—Lymphoma of the Plica Semilunaris—Nævus of the Caruncle—Papilloma of the Caruncle—Fibroma Papillare—Sarcoma of the Plica and Caruncle—Gumma.

TUMORS OF THE LACHRYMAL APPARATUS.

Histopathology—Classification of Lachrymal Tumors—Adenoma of the Lachrymal Gland—Adenocarcinoma—Angioma of the Gland—Dacryops—Cyst of the Accessory Gland—Dermoid Cyst—Endothelioma of the Lachrymal Gland—Epithelioma—Granuloma—Lymphoma of the Lachrymal Gland—Mickulicz' Disease—Mixed Tumors of the Gland—Adenosarcoma—Adenomyoma—Lymphangioma—Sarcoma—Mixed Sarcoma—Tuberculoma—Tumors of the Lachrymal Sac—Tumors of the Canaliculi—Prelachrymal Growths.

TUMORS OF THE CONJUNCTIVA.

Histopathology of the Conjunctiva—Adenoma—Angioma—Cysts of the Conjunctiva—Lymphatic Cysts of the Cul-de-sac—Dermoid of the Conjunctiva—Endothelioma—Epithelioma—Carcinoma—Fibroma—Granuloma—Hemangioma—Lipoma of the Conjunctiva—Lipodermoid—Lymphangiectasis—Lymphangioma—Lymphoma—

Myxoma—Nævus—Dermo-epithelioma—Osteoma of the Conjunctiva—Papilloma—Plasmoma—Plasmöcytoma—Polypi—Sarcoma—Melanosarcoma of the Conjunctiva—Leucosarcoma.

EPIBULBAR TUMORS.

Epibulbar Carcinoma—Epibulbar Epithelioma—Melanosarcoma—Myxoma—Epibulbar Sarcoma—Leucosarcoma.

TUMORS OF THE SCLERA.

Pigmented Nævus—Scleral Melanosarcoma—Sarcoma—Epithelioma.

TUMORS OF THE SCLERO-CORNEAL JUNCTION.

Limbal Epithelioma—Dermoid at the Limbus—Sarcoma.

TUMORS OF THE CORNEA.

Cysts of the Cornea—Dermoids—Epithelioma—Fibroma of the Cornea—Granuloma—Myxoma of the Cornea—Papilloma—Perithelioma—Sarcoma—Melanosarcoma of the Cornea.

GROWTHS OF THE ANTERIOR CHAMBER.

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TUMORS OF THE CHOROID.

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GROWTHS IN THE VITREOUS.

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TUMORS OF THE RETINA.

Angioma—Retinal Cysts—Glioma of the Retina—Pseudoglioma—Familial Glioma—Radiotherapy—Granuloma.

TUMORS OF THE OPTIC NERVE.

Pseudotumor and Pseudoglioma of the Nerve—Extra-dural Tumor—Classification of Optic Tumors—Angioma—Lymphangioma—Endothelioma — Glioma — Tubercle — Fibrosarcoma — Cyst — Osteoma—Sarcoma — Intradural Tumors — Hemangioma — Melanosarcoma — Psammoma—Myxoma—Lipoma—Gliosis.

TUMORS OF THE ORBIT.

Carcinoma—Endothelioma—Lymphangioma Cavernosum—Angioma of the Orbit—Dermoid Cyst—Teratoma—Fibroma—Lymphoma—Sarcoma—Orbital Chloroma—Melanosarcoma—Myxosarcoma—Chondrosarcoma—Fibrosarcoma—Treatment of Orbital Blood Cysts—Osteomata—Psammoma of the Orbit—Rhabdomyoma—Starvation Treatment of Orbital Neoplasms—Tumors of the Ocular Muscles.

INTRODUCTION.

By far the most comprehensive monograph on the whole subject of ocular tumors is the work of Lagrange, *Traité des Tumeurs de l'Oeil, de l'Orbite et des Annexes*, 1901-1904, in two large volumes profusely illustrated and replete with many clinical histories and reports of laboratory examinations. Little can be added to this exhaustive essay except to record the progress made in observation and experiment during the past fifteen years, and that is relatively of small value and interest.

In addition to the matter given under the subsections of this caption the student is referred to the headings to be found throughout this *Encyclopedia* under individual organs and tissues of the eye; for instance, **Iris**, **Lymphoma of the**, p. 6637, Vol. IX; **Sclera**, **Cyst of the**, p. 11599, Vol. XV; **Eyelids**, **Epithelioma of the**, p. 5003, Vol. VII—and so on.

Furthermore, the different forms of new growths affecting the eye are also treated under separate headings; and to these the student of ocular neoplasms is also referred. Among these are, for example, **Dermoids**, p. 3481, Vol. V of this *Encyclopedia* and **Sarcoma**, p. 11535, Vol. XV, together with other rubrics such as **Sarcoma of the choroid** that follow these principal heads. In the same way are discussed **Glioma** (p. 5579, Vol. VII), followed by **Glioma of the**

optic nerve, as well as by Glioma of the retina; Carcinoma, p. 1406, Vol. II, after which Carcinoma of the caruncle, Carcinoma of the choroid, etc.: Lymphoma of the eye, p. 7562, Vol. X; Psammoma, p. 10416, Vol. XII; and in this fashion through the whole list of neoplastic formations to which the ocular apparatus is subject.

From all this it will readily be seen that, except in the later literature, but little, apart from expressions of opinion by numerous observers, can really be added to what has already been set forth in various volumes of this *Encyclopedia*. Moreover, in the nature of things, there must necessarily be some repetition in treating so extensive a subject, scattered, as it is, over the whole realm of ophthalmic literature, if the matter is to be treated at all.

Instead of a (very extensive) bibliography, references will be found appended to or accompanying each subsection of the article under discussion.

With these explanations and provisos it is believed that a judicious selection of material is all that can properly be offered in the following pages.

HISTORICAL ACCOUNT OF OCULAR TUMORS.

Cancers were well known to the ancients, and the subject is referred to in the Ebers papyrus (B. C. 1500). Fragmentary documents of Indian, Persian and Arabian literature indicate a certain knowledge of neoplastic diseases. Treatment by excision and by various escharotic agencies, including arsenical preparations, was used with comparative success. Probably the earliest record of diathermia is by Hippocrates, who burned out a cancer of the neck.

Celsus, about the time of the Christian era, refers to several varieties of cancer, his classification being based on clinical and regional characteristics rather than upon definite pathological knowledge. Many swellings and enlargements observed at this period were looked upon as cancer, but with our present knowledge they are no longer so regarded.

Probably the first effort at a physiological and pathological understanding of tumors was fostered by Galen (A. D. 131-203). He classified swellings as *secundam naturam* (gravid uterus), *supra naturam* (callous formation) and *prater naturam* (true tumors). He described the dilated and traumatic form (aneurysm) and discovered anastomosis of the capillaries. This latter observation was not put to practical use until John Hunter's time in the eighteenth century. During the Galenic period Greco-Roman Medicine abounded in commercialism and quackery. Human vampires—dishonest and unscrupulous people

—conducted medical affairs. It was during this period that the *humoral doctrine* governed medical thought for upwards of a thousand years. See the section on **History of ophthalmology**, p. 8569, Vol. IX of this *Encyclopedia*. Of the four fluids of the body, blood, phlegm, yellow and black bile, the latter, in concentrated form, developed cancer where it gravitated to the face, lips, breast, etc.

Early in the eleventh century Ali Ben Isa of Bagdad, an Arabian ophthalmologist (see p. 224, Vol. I of this *Encyclopedia*), left his *Memorandum Book for Eye Doctors*, probably the earliest special work on, and most important contribution to, ophthalmology in existence from the most remote time even to the eighteenth century. In a translation into modern language, by Hirschberg and Lippert, evidence is present of the recognition of chalazion and the difference between cystic tumors, cancer and abscess resulting from inflammation.

Ammar of Mosul (*vide* p. 316, Vol. I), who followed Ali Ben Isa left a treatise entitled *Book of Selection of Eye-diseases*. Among the subjects dealt with, references to certain unnatural new formations are made.

With the introduction of Harvey's (1578-1657) discovery of the circulation of the blood, and of the lymph vessels, by Olens, in 1652, and largely helped by the invention of the printing press, certain definite progress was made which entirely discredited, or at least demonstrated many inaccuracies in, Galen's doctrines.

Morgagni (1682-1771) studied clinically and at autopsy syphilitic aneurism, gumma, cancer, lipoma, and exostosis. Astruc (1684-1766) differentiated cysts from true tumors. He also indicated a different prognosis in various forms of cancer. During Albrecht von Haller's time (1708-1777) the microscope was used in a limited way; histology and chemistry were born, pathology came to be studied intelligently, and embryology was developed. Wardrop (1789-1869) described a variety of swellings and attempted to differentiate them from cancer. Many of his patients were children, and in some instances the eye was involved. He describes one case which had its origin in a wart.

Bichat distinguished the stroma from the parenchyma in tumors. Recamier used the term metastasis following his observations on the infiltration of cancer and the destruction of veins. This advance certainly opened the way for the modern pathology of tumors, although tubercle, cancer, and gummata were imperfectly distinguished.

Modern scientific conceptions of new-growths, however, really date from the construction of the achromatic microscope—about 1824. Raspail showed that the growth of tissues results from the multiplication of cells. Collard described the stages of embryonal development of

tissues, assuming, however, that the cells originate from plastic lymph. Schwann discovered the nucleus and the nucleolus. In 1838 J. Müller published his monumental work on tumors. He found them all to be composed of groups of cells, each cell containing a nucleus and nucleolus. He held the interesting view that cancer develops not from normal tissue but from germ-cells. Regarding the origin of the cell it was held that most of them developed from plastic lymph, or blastema, by a process of budding. In a word, authorities of this period believed in the origin of cancer from a fluid blastema, an organized exudate from the blood, associated with over-nutrition and over-growth.

This theory was upset by Virchow's doctrine of "*Omnis cellula e cellula*." The new principle that cells grow exclusively from other cells by endogenous reproduction was adhered to rigidly, especially as to the origin and growth of tumors. He made, however, the error of believing that cancer-cells originate from connective tissue. Remak attacked the connective-tissue theory, which conflicted with the principle of the immutability of the three separate germ layers. Thiersch presented convincing evidence of the invariable derivation of epithelioma from living epithelium. He traced the growth of several epitheliomas from the glandular structures of the skin and demonstrated the principle "*omnis cellula e cellula ejusdem generis*." Waldeyer extended these observations, and demonstrated secondary tumors to be the result of continuous growth through blood and lymph-vessels as well as by cell emboli. He fully established the principle of the exclusive epithelial origin of cancer and its growth from its own resources. Thus is established the fact that malignant growths have a local origin and that secondary growths arise from transported cells. Thus, with the dawn of the twentieth century, records of the past showed a vast amount of investigation resulting in theories which remained until a new era took its place. We now cling to a few theories, but concerning the mode of production of tumors in general and of cancer in particular we know little or nothing. Present century thought and investigation rather discourage the idea of embryonal rests and seem to point in the direction of chemical activity as a provocative factor. Smith's work on the experimentally produced crown gall in plant life points strongly along this line of thought. Certain, more or less recent, investigations on regenerative and proliferative phenomena and their possible relation to tumor formation, lend strong encouragement to the belief that the entire subject of tumor formation is on the eve of a complete reorganization, and, perhaps of enlightenment.

L. Loeb's (*Scientific Monthly*, Sept., 1916; *Jour. of Cancer Research*, V. 2, No. 2, Apr., 1917) remarkable experiments on guinea-pigs in the production of deciduomata by mechanical injury, and the chemical activation by the sensitization of the uterus by the *corpus luteum* is in this direction. Horst Oetle's theory suggests that the nucleus contains chromatin of two orders; one governing functional, and the other proliferative activities. In his opinion the primary cancer cell is one that has sustained a loss of certain chromatin constituents of the first order. Cells so converted cannot reproduce their lost function but are able to give rise to daughter cells having vegetative attributes only.

Saxon (*International Clinics*, V. 1, 26th series 1916, p. 129) states as his belief that there are many kinds of stimuli capable of producing tumors and that these are, in the main, chemical. They may be called activators, as they convert cells of the plant variety into a vegetative phase, thereby causing proliferation which in some instances is purely vegetative and in others only partly so, but with persisting functional attributes. The same research worker found that in a series of experiments, in which one thousand rats and mice were inoculated with the products of malignant tumors, there was not one instance of metastasis to distant parts, thus showing that the experimenters were working under uniform conditions of virulence and immunity. Where, however, cholesterol was added to the diet of these animals widespread metastases were found in every case. This experiment affords a definite example of the effect of chemical substances on tumor formation.

An interesting phenomenon in this connection is the regeneration of the crystalline lens of the triton from the iris. This is an instance of the formation of a definite, highly specialized type of tissue, originally of ectodermal origin, from an entirely different type of tissue, itself highly specialized, but of mesodermal origin.

Keeping in mind these cell changes, may it not be possible that the mode of metastasis of tumors is far different from what we have supposed it to be? Clinically, the word tumor is not likely to disappear, but to the pathologist it has lost much of its former significance. Owing to the improvement in microscopic work, the study of the relationship of microorganisms to many swellings called tumors, has caused a revolution in our beliefs, so that the term has been stripped of its former wide meaning. Each increase in our knowledge regarding "swellings" reduces the list of morbid conditions known as tumors, either by eliminating them entirely or by combining certain apparently diverse conditions.

Definition of tumor. In its etymologic sense, this term signifies

“a swelling.” The definition has been restricted by advancement of our knowledge of histologic chemistry and a study of the relationship of microorganisms to many swellings formally called tumors. However that may be, *tumor* (L. a swelling) was a term applied from the earliest period of medical literature to any swelling of which the nature and origin were unknown. Thus used, and in its most literal sense, the word is of purely clinical derivation and has no pathological significance of any kind. Consequently, a heterogeneous collection of swellings has been described as tumors, including such diverse conditions as abscess, a tubercular gland, the enlarged spleen of malaria, a cancer, etc. With the progress of bacteriology and the improved technique of histology it has been found possible, however, to separate these various “swellings” into certain groups; e. g., (1) *inflammatory or infective tumors*; (2) *tumors due to hypertrophy*; (3) *cysts*; (4) *spontaneous tumors or tumors proper*.

The tendency of modern convention is to restrict the use of the term “tumor” to the last group; but for the sake of completeness it is necessary, also, to touch briefly on the distinguishing features of the first three groups.

Infective tumors are swellings due to microbial action, causing inflammation and following a typical course. *Hypertrophic tumors* are swellings due to increase in size of a tissue or organ, but remaining normal in structure. *Cysts* are swellings due to a collection of encapsulated fluid. Ziegler defines a tumor proper as a new-growth of tissues which apparently originates and grows spontaneously, which possess an atypical structure, does not subserve the uses of the organism, and reaches no definite termination in its growth. According to Birch-Hirschfeld, tumors are progressive new-growths of tissue arising spontaneously from cells of its own, and separated from normal tissue both in morphology and in function.

The *nature of tumor growth* is different from that of the normal tissues and from inflammatory hyperplasias; it is something new and foreign to the organism in which it occurs. The growth is normally expansive, emanating from an isolated group of cells and pushing contiguous tissue before it. Growth of a tumor is usually progressive, and no natural termination is realized. Yet the progressive quality is not invariable, since some tumors degenerate spontaneously, or necrose or long remain quiescent. This is illustrated by a retrogressive glioma. Some are more or less encapsulated; in others the growth assumes a proliferating activity, sending prolongations outward and permeating the adjacent tissues. Tumor cells acquire this proliferative activity greatly in excess of normal tissue.

The difficulties in clearly defining the various forms of tumor must be apparent, yet the essential thing for clinical purposes is to appreciate the entirely different pathological processes involved in tumors, inflammatory swellings, cysts and hypertrophies.

Classification of tumors. Microscopic study of the structure of tumors having revealed that they are composed of tissue normally existing in the body, pathologists realized that the structure of a tumor invariably corresponded with that of the tissue in which it grew. Thus an osseous tumor of the orbit resembles bone; an epithelioma of the lid is from epithelium, etc. There are, however, some anatomic conditions which distinguish benign from malignant tumors. Thus, *benign tumors* usually possess an investing envelope known as a *capsule* by which they are isolated from the tissue from which they spring; they do not infect the neighboring lymph glands; they do not recur after complete removal, and they rarely imperil life save when growing in connection with or in immediate vicinity of vital organs.

Malignant tumors, on the other hand, are rarely encapsulated and tend to infiltrate the lymphatics of the part affected; they are exceedingly liable to recur after removal; they tend to become disseminated through the lymph and blood stream, and usually destroy life.

It is a feature of benign tumors that they are apt to be multiple; for example, neuromata of the optic nerve, verruca of the lids, osteomata of the orbit, etc.; but the occurrence of two primary cancers is excessively rare. The coexistence of two varieties of simple tumor is not rare and an organ which is occupied by a benign growth may also become the seat of malignant disease.

Tumors have from very early times been arranged in malignant and benign groups. This division is sound because malignant tumors belonging to the connective tissue group (sarcomata) as well as those of the epithelial group (carcinomata) present structural peculiarities which enable competent histologists to recognize them. It is important to remember that benign tumors may and often do destroy life. The essential difference between a benign and a malignant tumor may be expressed thus: The baneful effect of benign tumors depends entirely on their environment but malignant tumors are generally fatal whatever their situation. This is known as the "law of prototypes."

The more carefully the histology of tumors is investigated, the more obvious does it become that the borderland between benign and malignant species is not well defined. This has been very definitely revealed in the case of dermoids. Few tumors had a better reputation for innocency, yet we now know that the less typical forms are liable

to dissemination. Realizing the uncertainty attending the diagnosis and prognosis of tumors the practice advocated by eye surgeons in dealing with them is sound; viz.: removal whenever practicable and at the earliest possible moment.

It may be stated without fear of contradiction that no one has succeeded in framing a satisfactory classification of tumors; and they have been classified *etiologically*, *regionally* and *histologically*.

Etiologically, is to consider whether a growth is congenital or post-natal in origin; the former is illustrated by the striking hereditary characteristics of glioma of the retina; the latter by those growths that develop after birth and result from mechanical, chemical or light irritants.

Regionally, is largely the grouping of histological varieties in different organs, as choroidal sarcoma or retinal glioma.

Histologically, the growth is named according to the tissue which it most resembles, and yet this arrangement is by no means satisfactory since certain malignant tumors do not simulate any normal tissue. Illustrations are *angioma*, composed of blood vessels, and *rhabdomyoma*, composed of striated muscle. The more recent tendency, wherever possible, is to name a growth according to its histology, qualified by its histogenesis, as *neurofibroma*.

Tumors vary widely in appearance, yet their gross characteristics are usually recognized by inspection and palpation. Certain features should be observed, such as the presence of ulceration, the rate of growth, peculiarities in markings and texture, the consistence (smooth or fungoid), the color; and whether or not circumscribed.

In considering the malignancy or benign character of tumors, it is well to remember that all of them, as before stated, may occasionally prove fatal. Malignancy is a term restricted to tumors with certain injurious features such as infiltration, local destruction and interference with function, recurrence after removal and metastasis. While it has been demonstrated that benign tumors are susceptible of being changed to malignancy, yet this is relatively of rare occurrence.

Metastasis of tumors. The appearance of a secondary tumor is one evidence of the destructive property of malignant tumors. The appearance of a second growth may indicate either multiple origin, extension from the original, or a true metastatic growth by the blood and lymph channels. Instances of contact growths are also on record.

Metastatic growths are of comparatively infrequent occurrence in the eye, largely because of anatomic conditions. The ophthalmic artery, which is of small size, is given off from the internal carotid at an angle of ninety degrees. The left carotid, arising from the aorta

directly, would be expected to receive emboli more easily than the right, and we should therefore expect metastases to occur more frequently in the left eye than in the right. Statistics do not show this to be true, however.

The most frequent site of metastatic growths in the eye is at the posterior pole, owing to the large calibre of the short ciliary arteries. Of twenty-eight cases mentioned by Ball (*Modern Ophthalmology*), the primary growth was located in the breast in twenty cases, in the lungs in three, in the liver in two, in the stomach and liver in one, in the suprarenal capsule in one, and in the thyroid gland in one. In one-third of the cases the disease was bilateral. The ages of the patients ranged from thirty to fifty-eight years. The disease is twice as frequent in females as in males. In metastatic carcinoma, vision is destroyed within a few weeks after the appearance of ocular symptoms. The average duration of life is about six months.

Pseudotumor. An important and comprehensive account of *pseudotumor*, including a review of published cases of *cryptoglioma* and *cryptosarcoma*, is found in the paper of Edward Jackson (*Am. Journ. of Ophthalm.*, p. 397, June, 1920). A number of illustrative examples from his own experience are detailed by the writer.

Tumor, which originally meant any swelling, has come to have a restricted meaning that is hard to define, but quite definite in its common use as more or less synonymous with neoplasm. In this sense the most important tumor of the uveal tract is sarcoma; although carcinoma and angioma are not excessively rare. The differential diagnosis between these, and tuberculoma, syphiloma, hematoma, and inflammatory swellings is of practical importance. For the former, local measures, excision or possibly applications of X-rays or radium are essential; for the latter appropriate general treatment is to be considered.

In the *diagnosis of glioma*, the recognition of inflammatory changes in the vitreous under the name pseudoglioma, has given impetus to the diagnosis of retinal tumors. *Pseudotumors of the orbit* have also been frequently considered, with the view of discriminating between them and tumors in the restricted sense. The *choroid, iris, and ciliary body* also furnish a considerable class of lesions that more or less closely simulate the true tumors. To think of them as pseudotumors is likely to fix attention on those peculiarities of appearance, progress, and history that may reveal their difference from tumors in the restricted sense—the neoplasms.

Most lesions of the iris are so open to inspection, that error or uncertainty with regard to their nature can be set at rest by repeated

careful examinations, extended over a sufficient length of time. "I have seen a few thickenings and pigment spots of the iris that had been regarded with suspicion by others; but which I thought non-progressive and devoid of danger. I have also seen one case of long noticed pigmented thickening of the iris, which I regarded as probably a slow growing sarcoma, while others thought it not of that character, on account of its long duration."

In 1893 the writer saw with M. W. Zimmerman a patient who presented in each pupil a darkly pigmented mass, apparently projecting from the back of the iris; which was thought to be probably a melanotic sarcoma. George C. Harlan was also consulted and pointed out that the smoothness of the iris in front of these pigmented masses seemed to indicate that the attachment was not to the iris, but probably to the anterior portion of the ciliary body; and that the outline of the mass in the pupil was rather that of a cyst.

If this condition had affected but one eye the patient would have been urged to have it enucleated at once, although vision was good. But this could not be advised for both eyes. Dr. Zimmerman kept the case under observation, and studied it for four years. He then reported it as a case of probable cysts arising from the ciliary body. The masses had not changed much, but remained a good deal as when first seen.

In a case reported by Stephenson a similar appearance was observed in the pupil, and the diagnosis of melano-sarcoma made and the eye enucleated. After enucleation, with transillumination of the globe "the pigmented mass appeared as a solid projection jutting into the illuminated pupil." Microscopic examination revealed one large and several smaller cysts, formed by separation of the layers of the iris.

The *ciliary body*, hidden from ordinary inspection and normally opaque to transillumination, rarely gives direct external evidence of disease. But gumma of this region occasionally gives rise to an appearance of tumor. Another rare and very instructive condition is reported (*Am. Journ. Ophthalm.*, May, 1920, p. 372) by Harrington. The tumor at the limbus, a common location for dermoids, presented the usual appearances and history of a dermoid tumor. But when the attempt was made to remove it, its real nature was found to be a coloboma of the sclera, with hernia of uveal tissue.

When, by pressing in the ciliary region for the ophthalmoscopic examination, after the method of Trantas, this part is brought into view, the same appearances might be presented as are seen in other parts of the fundus in ordinary ophthalmoscopy.

Eyes have been removed for *sarcoma of the choroid*, when they contained no sarcoma. In some cases there seems to have been little evidence to support the suspicion; but in others the most thorough expert examination left great uncertainty as to whether or not a neoplasm were present.

One of the most striking cases of *pseudotumor of the choroid* is that shown by the late R. L. Randolph (*Trans. Am. Oph. Soc.*, p. 446, 1910). This was the case of a man aged 28, who had been losing the sight of his left eye for over a year. Randolph was inclined to think the mass an inflammatory exudate. No one who saw the case offered more than a possible diagnosis. Scleral tumor, gumma, and tuberculoma were suggested, beside sarcoma.

Three years later, Dr. Randolph reported that in spite of negative Wassermann and tuberculin reactions, potassium iodid 100 grains three times daily for 7 months, and tuberculin twice a week for three months had been tried; but without effect. Lately the lower nasal aspect of the mass had been getting irregular, as though undergoing absorption.

Hird's case must have presented appearances closely resembling the above. No picture is given but the description of the clinical appearances is as follows: "The macular region was occupied by an almost circular pale yellowish white area which was raised above the general level of the fundus, the swelling measuring just four diopters in the center. The edges of this swelling were sharply defined, and there appeared to be no change in the choroid and retina around it. Springing from the upper and outer part was a prolongation, like a tail, which ran upwards and outwards, widening and losing its definition until it was lost in normal fundus at the periphery. There was some pigment at the lower and outer part of the swelling, and also some pigment at the root of the tail and along it. There were three hemorrhages in the retina, two between the swelling and the optic disc, and one at the superior border of the tail just where it joined the main mass. There were some fine pigment dots in the retina scattered about the fundus below the swelling. Branches of the retinal vessels—both arteries and veins—ran over the surface of the swelling. There was no detachment of the retina anywhere to be seen, and the peripheral field of vision was normal."

This case was shown at the Midland Ophthalmological Society, but no one ventured to make a positive diagnosis. Both doctor and patient preferred to have the eye removed. The showing of the microscopic examination is referred to below.

In Ormond's case "on examination of the left eye a large solid

detachment of the retina was seen situated below and on the outer side of the optic disc. The inferior temporal vessels passed over it. The detachment was circular and dome shaped, with a white soft looking surface, edged by numerous small hemorrhages. The top of the swelling was seen with a +7 D. sph." In spite of the negative report from a medical examination, tuberculin injections gave a reaction, and three months' tuberculin treatment noticeably reduced the size of the tumor.

Wray reported a case in which the ophthalmoscope showed "the posterior part of the globe is occupied by a large spherical neoplasm probably at least five or six times the diameter of the disc. Its anterior surface is seen with a +18. sph. The retinal vessels course over its anterior surface and run evenly with little distortion, whilst the retina itself is fairly translucent, and in places there can be seen through its texture what appears to be larger vessels, roughly about twice the diameter of the retinal vessels." Because of its translucency this was supposed to be a cyst. But in discussion Harman instanced a case of translucent detachment, caused by a sarcoma arising from the optic nerve entrance and quite out of reach of transillumination.

In the case of Paton and Collins, the large translucent *detachment of the retina* was assumed to be due to angioma, because there was a large nevus at the margin of the orbit. This diagnosis was confirmed after enucleation.

In Friedenwald's Case 1, the ophthalmoscope showed in the right eye "in the upper nasal quadrant, reaching to a point near the upper inner margin of the disc, a large, bluish gray, rounded, elevated mass, the highest part of which could be seen with +12 D. The projection of the growth was, therefore, about 10 D. into the vitreous, indicating a thickness of a little more than 3 mm. The extent of the growth was about six or eight times that of the optic disc."

Numerous other cases have been reported in the literature in which the question of choroidal tumor had to be seriously considered, but was negatived by the subsequent course of the case or the microscopic examination of the enucleated eye.

In Randolph's, the tumor was probably a choroidal or retrochoroidal inflammatory exudate. Ormond's case was probably tubercular. In Wray's patient the lesion appeared to be a cyst, although no evidence of its parasitic origin was discovered.

Hird found in the eye he removed a retinal mass 5 mm. in diameter and 1 mm. thick; which a committee composed of Collins, Parsons,

and Mayou considered was a form of retinal disease with massive, exudation, as described by Coats.

On a *diagnosis of sarcoma of the choroid* Knapp excised an eye; and found on microscopic examination a subretinal exudate of organized connective tissue, embedding the retinal pigment epithelium. The choroid showed no inflammatory infiltration; and its vessels and those of the retina were normal.

These cases have been brought together to enforce certain points applicable in the practice of every ophthalmologist.

Pseudotumors of the uveal tract occur, which on first examination present every appearance of true tumors—malignant neoplasms.

These masses vary widely in character and causation. After careful and prolonged tests for syphilis and tuberculosis, the widest range of investigation may throw little light on the origin or the essential character of the lesion.

Malignancy of such lesions can usually be excluded, by watching them over a period of several months or even years. Atrophy of adjoining parts of the choroid, or pigment deposits such as accompany choroidal atrophy, oppose the idea that the lesion is really a neoplasm. Very careful drawings should be made when the case is first seen; and the appearances found subsequently compared with them, to determine if the tumor is extending.

So long as the mass does not increase, watchful waiting is justified, if the eye still retains vision. If the tumor is malignant early removal is of course to be recommended. But for a choroidal sarcoma in the first stage the risk from a few weeks' delay until it shows unmistakable progress is problematic, and scarcely to be weighed against the loss of a useful eye on a doubtful diagnosis. If the affected eye is already hopelessly blind, that is another matter. Such an eye should be removed on the mere suspicion of malignancy. But for a seeing eye, true conservatism requires careful observation; with full records of the conditions present and delay until time makes a more positive diagnosis possible.

Of probable value in the diagnosis of doubtful cases of intraocular tumors—especially in those that go by the name of *crypto-sarcoma* or *cryptoglioma* (Schöbl)—the posterior ocular transilluminator of W. B. Lancaster (*Trans. Amer. Ophth. Soc.*, xiii, part 2, 1913) is not to be forgotten. He describes it as follows: A tungsten lamp is mounted on the end of a copper tube, which contains the necessary insulated wires. The tube is about 3 mm. in diameter and 70 mm. long. Current is supplied by the well-known pocket-flash-light battery.

The tube, being of soft copper, can be bent to suit the requirements of the case. In using the instrument it is necessary to make an opening in the conjunctiva and the capsule of Tenon through which the lamp is passed directly to the point desired. As the method necessarily inflicts more or less traumatism, it is recommended only in cases where the alternative is a more serious operation or where the diagnosis must be unmistakable and immediate.

The instrument was demonstrated on a rabbit, and, although the room was not darkened, the pupil showed a bright illumination.

Lancaster's apparatus was demonstrated at the Washington (1913) meeting of the American Ophthalmological Society and it is believed that, when perfected, it will prove of extreme value in the exact diagnosis of many puzzling intraocular growths. Schöbl was probably the first to insist upon the impossibility of making more than a mere guess in certain cases, especially those in which a neoplasm is covered or obscured by a massive exudate. Moreover, in those instances when a sarcoma is accompanied by a choroiditis, a hazy vitreous and minus tension or normal tension, a diagnosis was a few years ago, (as it often is now) only a guess. On account of its help in the diagnosis of massive exudates from cryptic tumors, Lancaster's device is welcome. See **Cryptoglioma**, p. 3573, Vol. V of this *Encyclopedia*.

A study of the published reports of tumors of the ocular apparatus for the past eighteen years, that is to say from 1903 to 1920 inclusive, reveals the fact that a very *extensive literature* has developed on this particular branch of ophthalmology. The bases upon which this study was made are mainly the abstracts and reports of the *Ophthalmic Year-Book*, edited by Edward Jackson, a large number of original contributions, and Lagrange's monumental work.

An idea may be gained of the enormous number of articles, etc., written during this period by the fact that there were about 1,723 published items, recording about 2,720 cases. The number of cases reported exceeds the published papers, notes, etc., owing to the fact that certain papers report two or more cases of the same or different structures; or a paper made a statistical study of a series of cases reported at various times from other sources.

It is to be appreciated that the published case reports of tumors of the ocular apparatus are merely to be taken as a guide indicating the comparative frequency or variety of particular types of neoplasm. They in no way express the total number of observed cases, as many such instances, of course, never find their way into the records.

A certain latitude in the application of the term tumor will be exercised in the following comments on new-growths of the ocular appa-

ratus. The various component structures of the visual organ and their relation to neoplastic diseases will be discussed in the following order, *eye-lids*, *lachrymal caruncle*, *lachrymal apparatus*, *conjunctiva*, *cornea and limbus*, *sclera*, *iris*, *ciliary body*, *choroid*, *retina*, *muscular apparatus*, *optic nerve* and *orbit*.

TUMORS OF THE EYELIDS.

The normal lids (see, also, p. 4987, VII of this *Encyclopedia*) are folds of skin anteriorly and mucous membrane posteriorly, with certain underlying structures, that afford protection to the eye ball. The upper lid is rather sharply defined above, but the tissues of the lower lid mingle with those of the cheek without any well defined boundary. Between the two lids lies the palpebral fissure. At the external canthus the lid margins form a sharp angle, while at the internal angle they make a horseshoe-shaped depression, in the center of which is placed the caruncle on a deeper plane than the lids.

The skin which is readily movable differs from that of other parts of the body in its looseness of attachment, thinness and absence of fat. Scattered pigment cells are found in the *cutis vera*. In the *stratum malpighii*, pigment is also found, more particularly near the internal canthus. Over the skin surface are fine hairs; at the anterior lid border they are stronger and more prominent, arranged in two, sometimes more, rows; and are called cilia. The cilia are lubricated by large sebaceous follicles called Zeiss's glands; Moll's glands are sweat glands, situated behind the hair follicles, that empty into Zeiss's glands.

The free margins of the lids have an anterior, rather rounded, and a posterior sharp border. The interval up to the anterior border is covered by conjunctiva. The posterior surface is clothed by conjunctiva reflected from the bulbar tissue. Contained within the confines of the skin and conjunctiva is the tarsus, a tough, fibrous, non-cartilaginous plate, thinning as it passes toward the base of the lid. Placed in the substance of the tarsus are the Meibomian glands. The levator palpebræ superioris is found in the upper strands of the inferior and oblique muscles; in the lower is the orbicularis palpebrarum. Müller's muscle, veins, arteries, nerves and lymphatics constitute the balance.

Deliberating upon the great variety of tissue entering into the construction of the lids it is not astonishing to note the wide variation in type and character of tumors of these organs. During the past eighteen years there have been published about 160 papers, clinical notes, or demonstrations of true tumors of the lids—recording, in all, 224 cases. The number of reported cases exceeds the number of pub-

lished papers, clinical notes or demonstrations because, as before explained, certain papers are statistical, others contained observations of an author's experience with two or more cases. For example, Morax tabulated 22 cases of plexiform neuroma of the lids; Buchanan studied and classified 55 reported cases of epithelial tumors of the lids; de Schweinitz and Shumway in 1911 studied 80 recorded cases of sarcomata of the lids thus adding to Wilmer's study in 1894 of 35 cases to which Veasey added 11 cases, while Alling had brought the total up to 65 in 1907. In other instances only one published report on certain types of tumors has appeared. Some of these were on tumors of unusual rarity, as for example Schnaudigel's report of a rhabdomyoma of the eyelid and Alt's observations on a leiomyosarcoma. A pure colloid new-growth was studied by Bedell; Derby and Verhoeff discuss very fully a case of sarcoid; Girgis observed an epithelioma in a very young child.

Adenomata of the lids may, according to Fuchs, involve the sebaceous glands, the glands of Krause, the sweat glands, the glands of Moll or the Meibomian glands. According to Ball these tumors are rare. Parsons (*Pathology of the Eye*, Vol. 1, p. 26), believes that Meibomian adenomata are commoner than the literature would lead one to expect. It is not unusual to meet with compact chalazia that do not respond to the usual treatment. It is possible that some of these are really adenomata. Collins and Mayou do not believe they are of very rare occurrence. They sometimes develop chiefly on the conjunctival surface of the tarsus and at other times on the skin surface.

Microscopically, lobules are found resembling large normal alveoli distended with polygonal cells, the more central of which show a tendency to degenerative changes. The distinctive features of adenoma of a gland of Moll is its location at the margin of the lid, a tendency to cystic formation, and the presence of a double row of cells lining its tubules, an inner of cylindrical epithelium and an outer of endothelium; a similar arrangement to that which is found in the normal gland.

The mass should be excised and like all suspicious growths should be examined microscopically. See, also, p. 4989, Vol. VII of this *Encyclopedia*.

The following cases illustrate these contentions. A female aged 65 years, consulted Fehr (*Cent. f. prak. Aug.*, Jan. 1915), on account of a voluminous tumor of the right lower lid which had begun as a little "pimple" nine years before and had slowly enlarged, especially during the last couple of years. A hard tumor, of reddish-brown color, was attached by a long, narrow pedicle to the outer two-thirds of the

edge of the lid without encroaching upon the conjunctiva or the skin in the neighborhood. The eyelid was pulled out of shape by the weight of the growth, which measured more than 3 cm. in length. The cornea was clear. The fundus was normal. Vision was 5/20. Although an exact diagnosis could not be made, yet malignancy could be excluded. The growth was removed, and the patient made a good recovery. No relapse occurred for the period of about a year, during which the woman was kept under observation. Fehr reports that the tumor, which was encapsulated, was composed in the main of gland tissue. It was, in fact, a typical adenoma, whether originating from the Meibomian glands or from the sebaceous glands of the edge of the lid the author was unable to decide with certainty.

In Letulle and Duclos's patient (*Ann. d'Ocul.*, cxlv, p. 203) the tumor grew in three years from the size of a millet seed to that of a bean. Its connective tissue stroma contained multiple cystic spaces filled with glandular processes and lined with a single layer of epithelium. Because of the non-acinous arrangement of the abnormal glands, and the presence of a capsule containing elastic and smooth muscle fibers, the authors consider that the tumor was a benign adenoma originating congenitally from the glands of Moll.

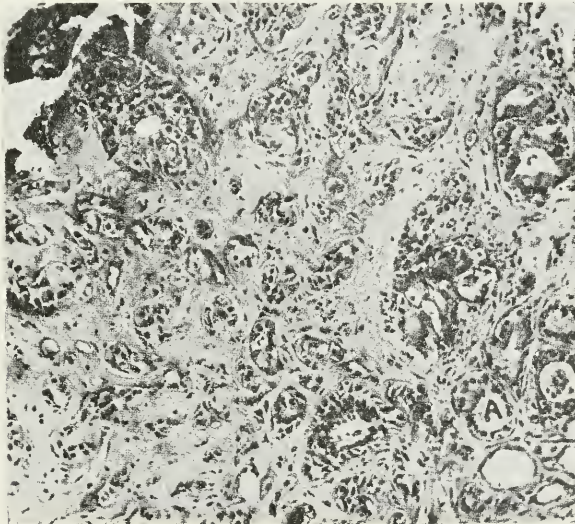
In Hesse's (*Klin. Mon. f. Aug.* July 1910) patient after removal of the adenoma there was a rapid recurrence involving the entire lid in a hard, irregular, partially ulcerated growth. The tendency to malignancy was evidenced by beginning infiltration of the surrounding connective tissue.

In Contino's (*La Clinica Ocul.*, p. 353, 1910) case an adenoma of the lid originated in the glands of Moll. Gargiulides (*Arch. d'Oph.*, reported V. 30, p. 178) an adenoma in the Meibomian glands. Cases are also reported by Pause (*Klin. M. f. Aug.*, Jan., 1905); Knapp (*Tr. Amer. Oph. Soc.*, 1903) and Komoto (*Nippon Grank. Zasshi.*, Apr., 1919).

Adeno-carcinoma. According to Coats (*Roy London Oph. H. Reports*, V. xviii, part iii) true adeno-carcinomata arising in sweat glands are of excessive rarity. Rodent ulcers, it is true, have at times something of a glandular aspect, and it is maintained by some authors that they may originate in sweat glands. The apparently glandular structure, however, is probably in most cases due to localized patches of degeneration; in any case, these tumors are quite different from those now under consideration. In this class of rodent ulcers are to be reckoned the cases of Alt ("adeno-carcinoma of the eyelid"); v. Graefe (*Adenoide*), and Spencer Watson (cystic epithelioma). In Coats' case, microscopic sections of which are illustrated, the proof of derivation from sweat glands seems to be unimpeachable.



Adeno-Carcinoma. A portion of the tumor close to the surface epithelium. The tubular character of the growth is evident, and the coiled arrangement characteristic of sweat glands is dimly shown. The epithelium is proliferating irregularly, and many of the tubules are filled up. (Coats.)



Adeno-Carcinoma. From the more malignant portion in the deeper part of the sections. The lumen is mostly lost, and the epithelial processes are infiltrating in a typically malignant manner. In the lower right-hand corner the tubular structure is still visible, and at A a portion of a lumen is lined by the normal double layer—inner cylindrical, outer small and flat. (Coats.)

Angiomata. Hemangiomata. These new growths are made up chiefly of and they develop from blood vessels. They usually form well-defined reddish spots or rounded tumors, located partly in the subcutaneous tissue and partly on the skin surface. The simple angioma is composed of dilated, thin-walled blood vessels. Upon compression the tumor becomes smaller but rapidly refills upon relief of pressure. Crying, laughing or other unusual exertion causes the tumor to enlarge. This growth may affect the margin of the lid as well as the skin surface, and portions of it may extend into the orbit. While not malignant angiomata show a marked tendency to increase in size.

The *cavernous* type of *angiomata* may appear as small, bluish growths or lobed masses. The interior is composed of large spaces filled with blood; any obstruction to the venous out-flow causes them to enlarge. They are of slow growth but may attain great size. See p. 4991, Vol. VII of this *Encyclopedia*.

Various methods are used, depending upon size and position, in the treatment of this condition. Complete excision is usually indicated. Caustery puncture, injection with hot water or alcohol and Clark's method of dessication are all useful procedures.

Among the contributions to the literature of this subject, Alt (*Amer. Jour. Ophthal.*, June, 1914) classifies hemangioma of the eyelid into *telangiectasis* and *cavernoma*. The former consists of innumerable, densely-packed, small blood-vessels which are not exactly capillaries and which cannot with certainty be called arteries or veins. Such a tumor has usually a lobulated appearance, due to numerous connective tissue septa which traverse it. According to Ogawa, these tumors grow, not by the throwing out of side branches, but by a continued growth in the length of the pre-formed vessels, gradually pushing the surrounding tissue aside. In the cavernoma, on the other hand, we find large cavities containing blood, separated by thin connective tissue walls lined with endothelium. Such a tumor may sometimes represent only one large (and continually enlarging) cavity due, probably, to the giving way of previously existing septa.

Telangiectatic tumors usually appear as reddish-blue smooth or lobulated swellings, while the cavernomata are more bluish or purplish.

Until recently Alt followed with considerable success H. Knapp's practice of excising hemangiomata of the eyelid. In the cases which have not been previously subjected to any treatment, it is usually possible to remove the tumor as a whole and thoroughly. The scar is generally small and not disfiguring. The author describes a case in which previous treatment had not succeeded. In this case Alt's operation of excision was also unsuccessful.

In spite of the usually good result of excision, if there are means to produce the shrinkage and disappearance of such tumors without any scar at all, it is better to use such means. In Alt's opinion, the cautery and electrolysis do not fall under this head. The more modern methods consist of injections into the tumor of boiling water or alcohol, and the treatment with carbon dioxid snow. The last two he has tried. The absolute alcohol treatment seemed to be of little use but the freezing method, although slow, gave a very good result in one case. In a little more than a year he froze the tumor twenty-one times. He began with an exposure of from twenty to twenty-five seconds, and gradually increased the periods to one minute. There is no longer anything to be felt of the tumor; yet, the nasal part of the lid is to a small extent evidently without tarsal tissues, and also devoid of cilia. The affected parts have not quite receded to their normal position, yet the child's eye is wide open, and the result is good.

Gifford (*Oph. Rec.*, Dec., 1906) reports satisfactory results by the injection of absolute alcohol.

The operative technique in the removal of an angioma of the upper lid in an infant, aged 6 months, is furnished by Charles (*Amer. Jour. Oph.*, July, 1906). A modified Desmarres clamp was used to control the hemorrhage. A skin incision was made along the inner edge of the clamp ring, the skin dissected from the growth, the vessels supplying the tumor at the temporal and nasal ends were ligated, and the growth dissected out. The skin flap was then sewed into position with fine sutures. The author reports but slight disfigurement.

A most interesting example of cavernous angioma of the eyelid was reported by the elder Risley (*Oph. Rec.*, Mar., 1906). It occurred in a child, aged eleven weeks, with a history of rapid growth of a tumor of the right lower eyelid. There was a dark-red, purplish, chestnut-like tumor occupying two-thirds of the lid. It was somewhat pedunculated. When the child cried the tumor became so tense as almost to burst. The growth was finally successfully removed by the use of an Ericson's suture.

Lemere (*Arch. of Oph.*, V. 43, p. 126) completely obliterated an extensive angioma by subcutaneous injections of nearly boiling water and occasionally of absolute alcohol. Capauner (*Klin. M. f. Aug.*, V. 52, p. 135) obtained good results in angioma following the use of carbon dioxide snow. Other cases are reported by Stilwill (*Oph. Rec.*, V. xxv, p. 97), Bloom (*Urol. and Cutan. Rev.*, V. xix, p. 326), Van Lint and Alt (*Polyclinique*, Nov., 1913).

Blastomycetes of the lids. Blastomycetic dermatitis. While not usually considered a tumor it is referred to in this section owing to

TUMORS OF THE EYE

the association which Russell, in 1890, described, upon finding certain large round bodies in cancer cells which were recognized as parasitic



Blastomycetes of the Lid. Dark area is the everted conjunctiva. Largest active lesion on cheek. Others on nose and about the ear. Scar tissue covers whole of right forehead. (Jackson.)



Blastomycetes of the Lid. Lesions progressive for seven months. Cicatricial contraction still comparatively slight. (Jackson.)

budding fungi. Upon this, the yeast theory of cancer was stimulated. Blastomycetes is probably more common than reported cases would seem to indicate. See **Blastomycetic dermatitis**, p. 1008, Vol. II.

Casey Wood (*Ann. of Oph.*, Jan. 1904) describes the condition as follows: The lesion always begins with an injury sufficient to allow the implantation of spores of the fungus. It runs a chronic course. The lesion begins as a red papule, which gives rise to a flat, wart-like growth with an elevated red margin. From under the crust a seropurulent discharge may be squeezed. The edges do not present the hard nodules of epithelioma. *Treatment* consists of X-ray and large doses of potassium iodide.

Jackson (*Jour. A. M. A.*, Vol. lxx p. 23) calls attention to the appearance of the lesion suggesting lupus, epithelioma or syphilis. He reports two cases. Wilder (*Jour. A. M. A.*, Dec. 31, p. 2026) and Fagin (*Ophthalmoscope*, V. xiii, p. 426), report six cases. Menage (*New Orleans Med. and Surg. J.* Vol. lxxiii, p. 299) and Pusey (*Tr. Sec. Ophth.*, A. M. A., 1904, p. 389) also furnish examples of the disease.

Carcinoma of the eyelids. This malignant neoplasm is of epiblastic origin. The skin surface of the lids, the various glands, conjunctiva, cornea and lens are of this embryonic layer. All these tissues are subject to malignancy, with the notable exception of the lens. During embryonic life the surface epithelial cells send prolongations into the sub-epithelial tissues, forming the glands, hair follicles, etc. After embryonic life this action ceases and the glands thus formed perform their various functions. If, later in life, there is a resumption of this proliferative activity, the glands, hair follicles, etc., cease to function and in their place there develops a malignant growth. During this process certain of the cells gain access to and grow along the lymphatic channels, developing fresh nodes in the intervening lymphatic glands. If proliferation remains local and does not invade surrounding structures a benign growth results.

See p. 1410, Vol. II of this *Encyclopedia*.

Carcinomata of the Meibomian glands have been reported. They are of alveolar type with large cells. The growth may ulcerate on either the skin or conjunctival surface. Microscopic sections show the down-growth of columns of epithelial cells, which divide and anastomose, and as they continue to proliferate, without being extended, compression takes place, thus forming "nests." Later the cancer breaks through the basement membrane and blends with cells of the sub-epithelial tissue.

While both epithelioma and rodent ulcer show practically the same changes yet clinically they are somewhat different.

L. Eymann (*Klin. Mon. f. Aug.*, 55, p. 339), gives the clinical history and microscopical examination of an epithelioma or *basal-celled carcinoma of the upper lid* of a man, aged 82, which started from the con-

junctiva of the intermarginal seam. The corresponding surface of the globe presented a marked carcinomatous exuberation of the corneal epithelium and the adjoining epithelium of the conjunctiva. The changes in the cornea and limbus were well circumscribed, so that a transmission of the carcinoma by contact was most probable, especially as the sections of the tumor of the upper lid showed towards the fornix a marked encapsulation by connective tissue, which spoke against a migration of the carcinomatous process along the mucous surface to the retrotarsal fold and from there to the anterior surface of the eyeball. The tumor of the lid exerted an intense pressure on the corresponding part of the ocular conjunctiva and cornea and a subsequent very close contact of both surfaces, by which a transport of elements of the tumor took place. Also at the maxillary angle a basal-celled carcinoma was found, probably a metastasis. Five similar cases and 16 cases of carcinoma of the palpebral conjunctiva are quoted from literature, which shows that they are very rare.

A *two-step operation for carcinoma* is strongly advocated by George W. Crile (*Interstate Med. Journ.*, July, 1915). He claims that after certain operations, especially those for cancer of the stomach, rectum and large intestine, the vitality of the patient gradually sinks to death and that the phenomena of this decline can be explained neither by the operation itself, nor by the patient's apparent condition before operation. In these cases the succession of symptoms is general loss of vitality, thirst, anorexia, depression, drowsiness, unconsciousness, and finally death, all in spite of the fact that the operative wounds are healing normally. What then is the cause of death if neither the disease process nor the operation is to be held directly responsible? Certain laboratory researches suggest both the cause and a means by which the fatal post-operative sequelæ may be obviated. These researches have shown that stimuli which activate the organs comprising the kinetic system—the brain, adrenals, liver, thyroid and muscles—increase the hydrogen-ion concentration—the acidity—of the body.

“We know that all the tissues and fluids of the body except the urine normally are alkaline and that a neutral or acid condition of the body fluids is incompatible with life.

“Normally, the acid by-products of energy transformation, in response to the ordinary stimuli of every-day life, are neutralized by the alkalies and bases received from food. If the body be subjected to an overwhelming activation, however, so that the stores of alkalies and bases in the body are insufficient to neutralize the sudden preponderance of acid by-products, sudden death—acid death—may result. On the other hand, if the body be subjected to a continuous abnormal activation, so that there is a continuous formation of acid by-

products in abnormal quantities, the mechanism especially involved in acid neutralization—the brain, the adrenals and the liver—is taxed beyond its powers, and either all of these organs or one of them, the weakest, falls under the continuous strain.

“That carcinoma is such a continuous activating stimulus is evidenced not only by its clinical effects, but by the histologic changes it produces in the brain, the adrenals and the liver, and by increased H-ion concentration of the blood.

“It can easily be seen, therefore, that in operations for cancer, the acid by-products resulting from the trauma of the surgical operation, from the anesthetic, and from the emotional stimuli might readily overwhelm the vital organs concerned in acid neutralization already taxed by the drain upon them of the constant stimuli from the disease itself.

“In addition, on account of the loss of appetite so frequently seen in cancer, the intake of alkalies and bases in the food is far below normal.

“These facts suggest various methods by means of which, in cases of cancer, the production of acids may be minimized and the stores of alkalies and bases increased.

“Food, water and glucose, and sodium bicarbonate should be pushed before the operation. Every possible psychic aid should be employed to diminish the emotional stress incident to the operation. Nitrous oxid-oxygen rather than ether is the anesthetic of choice, because we have found both in the laboratory and the clinic that ether alone markedly changes the brain, the adrenals and the liver, while nitrous oxid-oxygen alone not only does not injure these organs but measurably protects them against the damaging effect of surgical trauma.

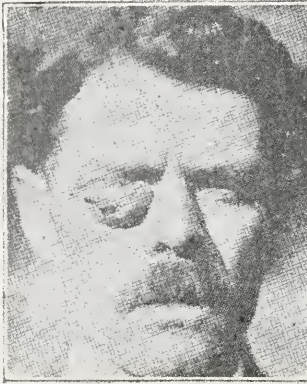
“Anociation should be employed throughout the operation, for observation both in the laboratory and the clinic have shown that the H-ion concentration, so markedly increased by trauma under inhalation anesthesia alone, remains unchanged under anociation.

“If examination of the blood of the patient shows a marked acidosis, morphin should not be administered, for while morphinization hinders or inhibits the formation of acid by-products, it also hinders or inhibits the activity of the acid-neutralizing mechanisms. Sodium bromide, therefore, should be substituted as a sedative in these cases.”

Epithelioma of the eyelids. The site of most frequent development is at the meeting point of the mucous and cutaneous epithelium. It appears as a nodule, wart or fissure; somewhat later developing into an indurated ulcer with undermined edges. After a time, nearby glands become involved; later, extension occurs, ending in death from hemorrhage or exhaustion. Early there is little pain; finally, the

suffering is severe. This condition occurs after middle life, and is said to be more frequent in males.

See p. 5003, Vol. VII of this *Encyclopedia*.

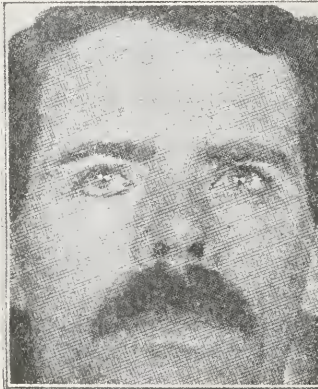


Epithelioma of the Lid.
Round cell sarcoma of lower
lid; condition before excision.
(Clark.)

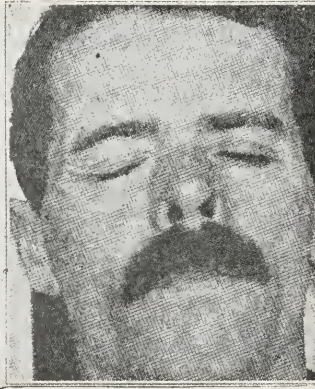


Epithelioma of the Lid.
Recurrence two weeks after
excision; treated by desicca-
tion at this stage. (Clark.)

A *differential diagnosis* between tuberculosis, gumma, lupus, rodent ulcer and chancre must be made. In syphilitic lesions usually the



Epithelioma of the Lid.
Condition one month after
one desiccation treatment.
(Clark.)

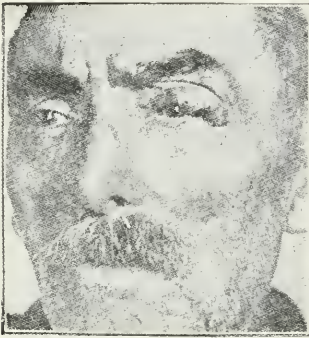


Epithelioma of the Lid.
Slight recurrence at inner
canthus nine months after re-
sponded to another treatment.
(Clark.)

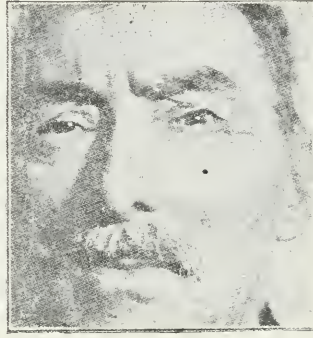
rapid growth, history of infection, Wasserman reaction and, in doubtful instances, the result of active, antiluetic treatment will clear the diagnosis. Lupus occurs usually early in life and is associated with

similar lesions of the face and nose. The ulcer is bathed in a non-purulent, non-offensive, discharge which is free from blood. Associated with this process the lids are red and swollen, a condition due to inflammatory change. The possibility of an epithelioma developing at a site affected with lupus should not be overlooked. In malignant cases the discharge is thick, scanty and blood-stained, and the growth is usually of slow development. In many instances a microscopic examination is the only means of making a definite diagnosis.

Rodent ulcer of the lid. Jacob's ulcer. See, also, p. 1381, Vol. II, and p. 6697, Vol. V of this *Encyclopedia*. This is a slowly-progressive new-growth, usually situated on the side of the nose, opposite the



Epithelioma of upper lid, involving cartilage. (Clark.)



Epithelioma of the Upper Lid. Result of one desiccation treatment; cartilage conserved; no recurrence in six months; note absence of contracted cicatrix. (Clark.)

inner canthus or on the eyelids. It begins as a small, firm, brownish nodule; later, the skin surface breaks, leaving an ulcer with undermined, thickened borders. In time it spreads, destroying the eyelids and extending into the orbit; even involving the bone. Jacob's description, given in 1827, is as follows: "The characteristic features of this disease are the extraordinary slowness of its progress; the peculiar condition of the edges and surface of the ulcer; the comparatively inconsiderable suffering produced by it; its incurable nature, unless by extirpation; its not contaminating the neighboring lymphatic glands. Microscopic study of the nodules show that the growth begins in the sweat and sebaceous glands, and later, in the ulcerative stage, involves the surface epithelium. The essential difference from epithelioma is the absence of 'nests,' and the presence of a great amount of fibrous tissue resulting from a more marked inflammatory process."

The treatment, for the various types of carcinomata, is excision, Roentgen-ray, and Clark's method of desiccation. Buchanan (*Internal. Clinics*, 20th series, ii, p. 161) has studied fifty-four cases of epithelial tumors of the eyelids. He divides them into two classes according to histological appearances: Class 1, in which the growth was found to be composed of irregular, club-shaped masses of flattened epithelial cells bounded by columnar cells and having a distinct origin from the skin in elongation of the interpapillary processes—squamous epithelioma. Class 2, those in which the tumor was found to be growing under a layer of thinned skin and in which the growth was composed of irregular, gland-shaped masses of oval epithelial cells of various sizes and shapes—glandular epithelioma or rodent ulcer.



Epithelioma of lower lid, inner and outer canthus, and malar region. (Clark.)



Epithelioma of the Lower Lid. Result of three desiccation treatments; no recurrence in fifteen months. (Clark.)

There were fourteen of the first, and forty of the second class. The average age in the first was 65 and in the second, 52 years. The average age at which the growth began was, in Class 1, 64.5 years; in class 2, 47 years. Forty-two were males and twelve females. The squamous type was rare in women. The history indicated that the squamous type always began as a wart; the glandular type, as wart, pimple or milium (one case). The squamous type grew as much in a month as the glandular or rodent ulcer in a year. Squamous epithelioma usually ulcerates rather early. Glandular epithelioma does not ulcerate until it is a year or so old, as a rule. In its early stage it presents the appearance of a tumor growing under the skin. The glandular type may exist for many years without involving the lymphatic glands, whereas the squamous variety grows rapidly, involving the lymph glands, and causes cachexia. Both types occur more frequently in the

lower than in the upper lid. For the glandular type he advises deep and thorough excision. If this cannot be carried out an ointment of formalin (10 per cent.) applied twice daily, is recommended.

A rare case of *epithelioma of the lid*, in a child aged 5 years was observed by Girgis (*Oph. Soc. of Egypt*, 1917, p. 87). The fungating growth covered both lids of the right eye, and extended on to the upper part of the cheek. It measured 2 by 3 by 4 cm. The tumor, together with the surrounding skin, subcutaneous tissue and fat was removed. Thiersch grafts were used, with no recurrence in sixteen months. Lt.-Col. Phillips, R. A. M. C., in discussing the case thought the condition might be a manifestation of xeroderma pigmentosum.



Epithelioma of lower lid and inner canthus, involving cartilage. (Clark.)



Epithelioma of the Lower Lid. Condition after one desiccation treatment; no recurrence in eight months; note absence of contracted cicatrix. (Clark.)

Menetrier and Monthus (*Soc. d'Oph. de Paris*, July, 1912) report the development of an epithelioma, together with chronic hyperplastic radiodermatitis, in a young patient who for ten years had been exposed professionally to the action of X-rays. The epithelioma was on the margin of the lid, and was apparently derived from the epithelium of a hair follicle.

Sheeres (*Klin. M. für Aug.*, Vol. lii, p. 86) removed a primary carcinoma, replacing the lost tissue by a Budinger operation. It was a flat tumor somewhat like a chalazion, involving the entire tarsus.

Valentine (*Brit. Jour. Oph.*, Vol. i, p. 540) removed an epithelioma of the lid. One year later the enucleated eye showed a fairly typical intraocular leuco-sarcoma. Palieh-Szanto, from his study of twelve clinical histories, concludes that basal-cell carcinoma predominates in the lids. Herz's (*Med. Rec.*, Vol. xci, p. 370) case resulted from the irritation of tortoise shell spectacles. Tolstoudhoff (*Viestnik. Oph.*,

Vol. xxx, p. 498) observed a primary carcinoma of the Meibomian glands.

The following observers also record cases. Faure-Lacaussade (*Rec. d'Oph.*, Feb., 1906, p. 110); Lafon (*Rec. d'Oph.*, Apr., 1906); Rollet (*Rev. Gén. d'Oph.*, Feb., 1906); Dupont and Roy (*Jour. de Méd. et de Chir.*, Mar. 26, 1910); Adamuk (*Viestnik. Oph.*, Vol. xxvii, p. 986); Moissonier (*Recueil d'Oph.*, Nov., p. 669, Bibl.); Troussseau (*Ann. d'Ocult.*, May, 1904); Katayama (*Nippon Gank. Zasshi*, Aug., 1916) studied three cases. Mills (*Arch. Oph.*, Sept., 1904, Bibl.); patient had an adeno-carcinoma. Marongin (*Arch. di Ottal.*, Vol. 26, p. 67) a melano-carcinoma.

In discussing the merits of the various methods practised in the treatment of epithelioma, William L. Clark's (*Jour. A. M. A.*, Sept. 12, 1914) experience, covering a period of ten years, has been such



Angioma of the Upper Lid.
(Clark.)

Angioma of the Upper Lid.
Result of one treatment by
desiccation. (Clark.)

that he has formed well-defined conclusions on the subject. The methods considered were operative surgery, chemical caustics, thermocautery, roentgen-rays, radium and electrothermic desiccation.

The classes of epitheliomata were confined to those of basal cells or rodent ulcer type. The key-note of success, so far as permanency of cure is concerned, was the thorough destruction of the local lesion, by whatever means employed, by *one* treatment; for he considered it folly to allow any malignant tissue to remain after starting treatment, for there was danger of stimulation of growth by so doing.

Nothing more was necessary in the class of epitheliomas under discussion, as they are of relatively low-grade malignancy, progress slowly, and seldom if ever undergo metastasis. Another factor of importance is the cosmetic result; and in choosing a method for the treatment of a given case the one that combines an equal chance of cure together with good cosmetic results should be selected.

The devitalization of adventitious growths by *desiccation* is pro-

duced by applying to the growth a sustained degree of heat that is not of sufficient strength to carbonize it, but of just sufficient strength to dehydrate it, converting the growth into an inert, desiccated mass. A concentrated, specialized electric current of high potentiality is utilized for this purpose.

Desiccation, in the author's opinion, possesses the following advantages: 1. Accessible abnormal tissue may be destroyed rapidly and effectively; and the operation is bloodless. 2. It is a method of precision. A small point may be destroyed without infringement upon normal tissue, as may an area of large size and considerable depth; and there is no danger of injuring the sclera. 3. No needle or other instrument is inserted into the growth. 4. The current has an anesthetizing property, which usually renders the application bearable. 5. There is a devitalizing action on cells of less vitality than normal cells somewhat deeper than the desiccated areas, the normal cells recovering. 6. There is sterilization followed by rapid repair. 7. Blood and lymph channels are sealed, which lessens the likelihood of metastasis in cases of malignancy. 8. There is an absence of contracted cicatricial tissue. Moreover, in choosing a method for the treatment of epitheliomas, especially those near the eye, the length of time in which there is freedom from recurrence is not the one important point to be considered, and should not be the deciding factor in determining the merits of a proposed method. After excision of epitheliomas of the canthi, no matter how thoroughly the work appears to have been done, there is a percentage of recurrence. In such case, if excision is practised a second or third time, there is usually unsightly deformity, often with exposure of the eyeball, notwithstanding the best plastic work. This is not true of desiccation. Should one or several recurrences appear, desiccation may be employed without the deforming results attendant on excision.

Operative surgery is efficient if performed radically, but the cosmetic results leave much to be desired. Secondary plastic operations often improve this condition, but more often fail. Operative surgery has the added disadvantage of opening blood and lymph channels, favoring recurrence. The best argument against operative surgery in the treatment of these lesions is the fact that cases are being continually referred for other treatment by the highest exponents of the art to ophthalmic and general surgery.

The use of *chemical caustics*, such as nitrate of silver, phenol, etc., is most reprehensible, as they serve only to stimulate the growth. Pastes of arsenic or zinc chlorid are often successful, however, when used by physicians experienced in their use; but the results are by no means constant, and even in the hands of experienced men, failures

can be readily seen. The depth of destruction cannot be accurately determined and if one malignant cell is left, recurrence is certain. The application is painful, there is danger of applying pastes on the eyelids, and there is frequent unnecessary scarring. When a good result is obtained it is a matter of luck. The *thermocautery* is superficial in action, tends to stimulate the lesion and produces a contracted scar. Its use should be condemned. This applies either to the thermocautery or electro-cautery.

The roentgen rays are successful in a fair percentage of cases, and when they are successful the result is ideal, both from a curative and cosmetic standpoint. The results, however, are by no means constant and from Clark's own experience and the observations and experience of the best roentgenotherapists he believed that there is a tendency to recurrence of the tumor in a large percentage sooner or later, unless it is treated very early. It also has been observed that when the roentgen rays are used to the limit and fail that the tissues are in worse condition for eventual recovery than before treatment. More than one X-ray treatment is usually required, and often the lesion is stimulated instead of retrogressing. There is also some danger to the eye in treating epithelioma of the lids.

The same objections apply to *radium* as to the X-ray, although often good results are obtained by them both.

The desiccation method is one which embraces the advantages of all and none of the disadvantages of the other methods mentioned. The X-ray and radium may, however, be used in some cases in conjunction with desiccation to advantage. Desiccation destroys the lesion thoroughly to any depth desired, and the control is so accurate that the smallest discernible point may be treated without danger, even in the cornea. Lesions may be destroyed with one treatment. Blood and lymph channels are sealed at once, and there remains no contracted cicatrix. There is a minimal amount of destruction of normal tissue. The percentage of recurrence computed from 150 cases of epithelioma of the eyelids, one year or more after treatment, was less than 3 per cent.

From a curative and cosmetic standpoint Clark believes there is no doubt that the desiccation method is far superior to any method known at the present time for the treatment of basal-cell epitheliomas of the eyelids and adjacent parts. Clark's ideas on this subject however are not in accord with those of the men who advocate excision of growths of the lids and canthi. Experience has led him from a curative and cosmetic standpoint to the conviction that excision is the least desirable method of treating localized epitheliomata. He states that

anyone who had ever seen such a growth destroyed by desiccation and had observed the results must be impressed with its merits.

A very interesting observation in the *treatment of epithelioma of the lid* is made by Ring. (*Amer. Jour. Oph.*, Jan., 1918). He exhibited a patient, aged 65 years, from whom he had removed, by surgical means, an extensive epithelioma 15 years previously. The lids remained normal up to two months previous to showing the patient. Seven years after the operation, the patient developed an epitheliomatous area on the cheek. This growth had been treated for several years by an expert roentgenologist, mainly by roentgen-ray and for some months by radium, to no purpose. A so called "cancer doctor" eradicated the disease in two months, when well known forms of radiant energy had failed after several years of trial, but with an unfortunate cicatricial contraction. The ingredients of the plaster were arsenic, sulphur, dogfennel and crowfoot.

Ring's purpose in presenting the case was not to advocate the use of plaster, notwithstanding its apparent merits, but to insist upon a less dogmatic adherence for so long a period to a method which had clearly failed. A prompt and satisfactory result could have been accomplished by the application of the method of electrothermic desiccation of W. L. Clark.

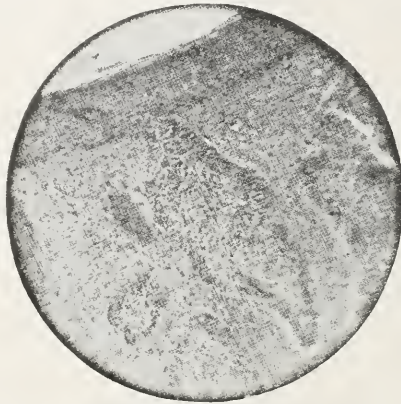
Massey (*N. Y. Med. Jour.*, Apr. 2, 1917) found *zinc ionization* by the unipolar method to be particularly well adapted for destroying small epitheliomata situated at the edge of the eye-lids, because of the small current strength needed, thus making it possible to depend on the electro-chemical union of the zinc ions with protoplasm as the destructive force alone, without development of effective heat for this purpose. The low voltage of the direct current is an important advantage in the delicate application in this situation. Complete destruction of the morbid tissue should be aimed at in one application of from fifteen to thirty minutes duration, with a current proportionate to the size of the growth. Twelve cases of operable growths remained free from disease for considerable periods after this treatment. In three inoperable carcinomata and three sarcomata the disease was not eradicated.

de Lapersonne and Degrais (*Arch. d'Ophthal.*, May-June, 1919) direct special attention to the necessity for precision in dosage in the use of *radium*. Radium therapy, like X-ray therapy, has passed through a period of empiricism, and dosage can now be determined almost as accurately as that of ordinary drugs.

It is now possible to indicate (1) the quantity of radium to be employed, (2) the use or non-use of a filter to regulate the depth to

which the rays will penetrate and (3) the duration of the application. Three cases are reported as examples. In all the results of radium treatment were wholly satisfactory. One case was that of angioma of the eyelid in a little child. The tumor was so large that it covered the eye and surrounding structures. It was treated by seven series of applications, at intervals of six to ten weeks. The other two cases, occurring in elderly women, are termed epithelioma; they appear to be what is commonly known as rodent ulcer in this country.

Carl Fisher (*Jour. A. M. A.*, Aug., 29, 1914) studied eighty-eight cases of *epithelioma primary in the lids and canthi*. The diagnosis in all cases was confirmed by microscopic examination. The author



Epithelioma of the Lid. Epithelial down-growth showing spindle and oval cells which, when in masses, often look like sarcoma cells. (Fisher.)

had chiefly in mind the prognosis of operative treatment. A good proportion of the cases had previously received long courses of salves, pastes, and Roentgen-ray treatment.

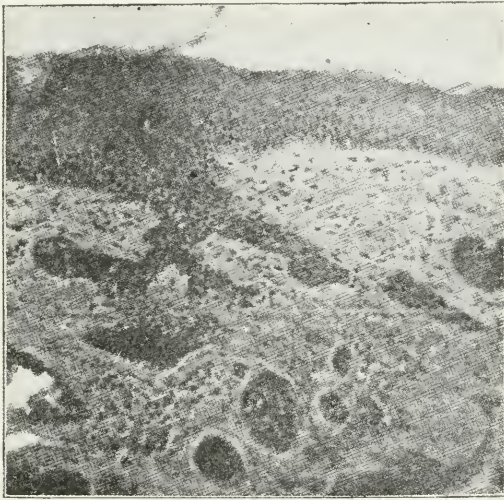
The epitheliomas of the lid all belonged to the type known as basal-celled, or, to use a rather popular term, rodent ulcer. By this is commonly meant, clinically, a cancer of the skin of very slow growth, with no tendency to glandular metastasis, spreading by continuity and usually ulcerating as it increases in size and area.

After the growth has progressed, both basal and squamous cells are to be found in the field, one or the other predominating. Sometimes the appearance of the growth may simulate sarcoma, from the tendency of the epithelial cells to assume spindle forms.

In Fisher's series, the average age of incidence was 53 years; the youngest, 24 years. Some tumors developed rapidly, that is, in one

month; and the average patient waited five years before coming for treatment. The point of predilection was the lower lid. This might be attributed to the irritation caused by tears and foreign matter.

This theory is consistent with the late J. B. Murphy's observation that it is the small trauma which is a factor in the production of cancer and not trauma of a gross nature. Of these series reported by Fisher, considerably over half originated in the skin near the cilia, the others starting indifferently on the very margin of the lid or its base. In five cases cervical and parotid glandular involvement was present when the patient was first seen. These two groups of glands drain all of the skin of the lid and the conjunctiva, while the orbit



Epithelioma of the Lid. Growth is taken from nose. (Fisher.)

drains into the internal maxillary group. Unsuccessful treatment seems to favor glandular involvement, since, of these five patients, only one had escaped pastes or Roentgen-rays.

The patients were treated by one of three methods—radical excision, excision with actual cautery, and simply actual cautery. Of thirty-three cases involving the lids alone 17 per cent. were not permanently cured. When the orbit was involved 80 per cent. were not permanently cured.

Fisher concludes that operative measures are, in general, the safest means of treatment. In a personal conversation, the writer of this section is permitted to modify Fisher's views, in that since writing the foregoing contribution, owing to an increased supply and better

knowledge regarding the use of radium, he has observed very different results than formerly. When proper facilities are obtainable, he believes good results are obtained by the use of this agent.

Ryerson (*Trans. Amer. Acad. Oph. and Oto-Laryn.*, 1912), after three years experience with radium, believes it to be a therapeutic agent of permanent value. Cavara (*Ann. d'Ocul.*, cxlvi, p. 256) discusses the method and results of radium treatment in sixteen cases of epithelioma in the Paris Charité.

Darier used 5 mgm. of radium for an hour and a half daily with excellent results in ten days. The purity of various salts varies greatly; enclosed in glass its effect is diminished 90 per cent. He employs the sulphate by fastening it to a copper plate by means of glue. Duncan (*Amer. J. Oph.*, Vol. 1, p. 715), in one hundred cases of superficial epithelioma of the face, lips and lids, obtained gratifying results with the use of radium. Moon's patient (*Jour. Oph. and Oto-Laryn.*, Mar., 1916) showed a recurrence following a Dieffenbach operation. Ten applications of five hours each with radium left no macroscopic evidence four years later. Holloway (*Sec. Oph., Coll. of Phy.*, Phila., Apr. 1916) curetted and applied pure carbolic acid twice, followed by radium treatment, with no recurrence in two months. Jessop (*Tr. Oph. Soc. U. K.*, Vol. 36, p. 245) and Garcia Del Mazo (*Arch. de Oft.*, 11, p. 505) also discuss radium treatment.

Tischner (*Klin. M. für Aug.*, Apr., 1911) reports five cures. Denti (*Zeitsch. für Aug.*, Jan., 1908) reports favorable experience; and Risley (*Ann. of Oph.*, Vol. 24, p. 437) observed improvements following the use of the roentgen rays. Troussseau (*Ann. d'Oculist.*, Jan., 1906) Rateria, and de Schweinitz (*Proceed. Sec. Oph., Coll. Phys.*, Phila., Dec., 1908) each discuss operative removal and radio-therapy. In separate communications the last author reports two cases in which the use of the roentgen-ray after excision of the growth gave smooth satisfactory healing.

Higgins (*Wis. Med. Jour.*, Vol. 24, p. 38), in whose six patients the growth extended over the inner canthus, did a complete removal of the eye followed by the use of the roentgen rays. De Lapersonne's (*Bull. Soc. d'Oph.*, p. 2, 1910) patient had had five operations in eighteen months.

Morestin (*Rec. d'Oph.*, June, 1908) reports a case in which radio-therapy for several months failed to give permanent benefit. The tumor was seated at the inner canthus and involved the canaliculi. Excision, with extirpation of the lachrymal sac and transplantation of a flap from the frontal region, gave a satisfactory result. In Jobson's (*Oph. Rec.*, Dec., 1908) case, curetting, cauterization and excision

were followed by recurrence. The removal of the lower lid, which was replaced by a graft from the arm, gave a good result. Posey (*Oph. Rec.*, May, 1908) reports a carcinoma of the upper lid the size of a small lemon. This tumor was removed and the gap filled by a flap from the forehead. Polya (*Zeitsch. für Aug.*, Sept., 1908, p. 271) reports a case where the extirpation of a carcinoma that had started in the lid required extension of the operation into the ethmoid cells and maxillary antrum. The orbit was closed by a secondary plastic operation. Johnson (*Arch. f. Oph.*, Vol. 46, p. 368), removed a growth of four years duration, restoring the parts with a Wolfe graft from the abdomen. Emerson (*Arch. of Oph.*, Vol. 44, p. 445) had no recurrence in three months following an excision of a V-shaped piece of the entire lid. Fergus (*Oph. Rev.*, Vol. 34, p. 1) has devised a flap operation in epithelioma of the lower lid.

Grignola (*Ann. di Ottalm.*, 39, p. 793) treated two cases of palpebral epithelioma with gelatinous discs of jequiritin. One case which he was able to follow had no recurrence for at least two years. In addition, Nobile (*Ann. di Ottal.*, 39, p. 685), Denti (*Ann. di Ottal.*, p. 258, 1909), Farina (*Ibid.*, Vol. 38, p. 291), Fumagalli (*Ibid.* p. 164, 1909), Bialetti (*Ann. di Ott.*, Vol. 41, p. 526), Rampoldi (*Arch. d'Oph.*, Vol. 30, p. 707) each obtained very satisfactory results by the use of the same agent.

Cary (*Trans. Sec. on Oph.*, A. M. A., p. 51, 1915) believes that the starvation treatment of malignant growths has undoubted value. This method consists in tying off and arresting completely the blood supply. The results seem most favorable when the tumor is not disturbed. The writer obtained best results in sarcoma, which is explained by the fact that sarcoma cells make up the vessel walls, thus receiving a rich blood supply. Ewing (*Amer. Jour. Oph.*, p. 328, 1909) found useful a combination of resorcin, salicylic acid, and oils of lavender, lemon and bergamot in alcohol. Sherwell (*N. Y. State Med. Jour.*, June, 1908), for superficial malignant growths, is pleased by the results obtained by thorough deep curetting, followed by applications of 60 per cent. solution of acid nitrate of mercury, neutralized after 10 to 20 minutes, with sodium bicarbonate. No dressing is applied, but the scab is permitted to remain undisturbed until it falls off, in two or three weeks.

Chalazion. Meibomian cyst. Tarsal tumor. Granuloma of the Meibomian gland. Although this tumor is usually described under inflammations of the lid, yet it seems fitting to include it in this section. It is occasionally referred to as a *cyst*, but this is not strictly correct, as it is really a mass of granulation tissue which may, secondarily, be-

come cystic. It is observed more frequently in adults than children; in the upper than the lower lids; it may be single or multiple, and is usually painless. The acute form may develop rapidly but it is usually of slow growth.

A chalazion is a small, round, nodular tumor movable with the tarsus in which it is imbedded. The overlying skin is also freely movable, the mass being non-adherent. Its growth may be in the direction of the skin surface (external chalazion) or toward the conjunctiva (internal chalazion). If the latter, upon everting the lid, the overlying conjunctiva is found thickened and of a reddish-gray color. When perforation of the conjunctiva occurs, the chalazion then shows a granulating surface, which impresses one with its similarity to a malignant growth.

Fuchs regards a chalazion to be a peculiar chronic inflammation which produces granulation tissue containing giant cells. Parsons states: "The epithelium of the acinus first proliferates without forming fatty sebaceous material so that the cytoplasm stains well. The central fatty cells are imprisoned and break down into granular amorphous flakes. The surrounding tissue of the tarsus is densely infiltrated with lymphocytes and the fixed cells proliferate. This process soon becomes the predominant one, so that both the acini of the gland and the periacinous tissue are ultimately lost in a mass of granulation tissue."

The growing tumor presses more and more upon the surrounding tissue, which becomes compressed, and forms a connective tissue capsule. The chalazion is poor in vessels, proliferation taking place chiefly at the periphery.

Authors generally are in favor of an infectious theory of chalazion, and many forms of bacterial origin have been offered in an endeavor to establish a specific etiology. Dyl found bacilli whose morphology was the same as xerosis bacilli. Fisch has demonstrated the presence of tubercle bacilli in the giant cells of chalazion, while von Michel (*Bericht der Oph. Gesell.*, 1911) does not believe there is a specific morbid agent. He thinks that chalazion is due to an acute inflammation of the Meibomian glands which is apt to become chronic through participation of the whole lymphatic apparatus of the lid; that it is inclined to recur, and that generally these growths may be granulation tumors of varying structure. Foreign body, giant-cells are characteristic but the presence of a capsule is irrelevant.

Lowenstein (*Arch. für Oph.*, p. 319, 1914) from his researches, believes that anatomically, two groups of chalazion may be distinguished: (a) cellular chalazion, mainly consisting of accumulations of plasmacytes with abundant vessels and infiltrations; (b) chalazion with

dense, polynuclear connective tissue and less cellular infiltration. Russel's bodies were found in several chalazia. No tubercular deposits were found. In a tuberculous child the chalazion reacted to each injection of tuberculin. No tubercle bacilli were found in the excised tissues.

It is well to differentiate between a chalazion, adenoma, hordeolum and sebaceous cyst; but of much more serious importance is sarcoma. In certain instances it is impossible in the early stages to make a *diagnosis* without the use of the microscope. Recurrent growths after removal should arouse suspicion of malignancy.

An acute chalazion should be incised and hot compresses applied. In the chronic type massage, as well as mercurial and iodine ointments are recommended but this treatment is usually unsuccessful. Surgical intervention is the method of election. If the chalazion is thinning the tarsus or pointing on the conjunctival surface it can be incised and the capsule curetted away. The most satisfactory method is incision through the skin surface and shelling the growth out.

Lafon (*Arch. d'Ophth.*, Nov., 1908) maintains that chalazion is acne of the Meibomian glands. The two lesions have the same anatomical structure, the same symptoms and the same causes, and must hence have the same pathogeny. Local irritation favors invasion of infectious agents which give rise to inflammation.

An elaborate study of the histology and pathogenesis of chalazion is published by del Monte (*Arch. di Ottal.*, Vol. 23, p. 84). He believes that he has demonstrated the cause to be a form of protozoa probably belonging to class *Sporozoa*, and order *Coccididea*. See, also, **Chalazion**, p. 1983, Vol. III of this *Encyclopedia*.

Colloid tumor of the eyelid, closely aligned with hyaline and amyloid changes, is really a degenerative process leading to the formation of a homogeneous mass. It is a condition of considerable rarity, and is probably due to chemical changes in certain exudates or secretions derived from lymph or blood plasma. The mass is usually of slow growth, has a poor vascular supply and is composed of slowly altering, inert material mingled with living cells, its subsequent history depending upon environment. In its late stages it shows evidence of calcification and ossification. It affects most frequently the conjunctival surface of the lid but the whole eyelid may be involved, becoming thickened and causing ptosis. At times the forehead and bridge of the nose may also be involved. See this *Encyclopedia*, Vol. IV, p. 2326.

Bedell (*Tr. Amer. Oph. Soc.*, 1915; Bibl.) reports a case in a man, aged 48 years, which had been present for two years. The upper lid was rounded by a firm mass of cartilaginous consistence, which was not

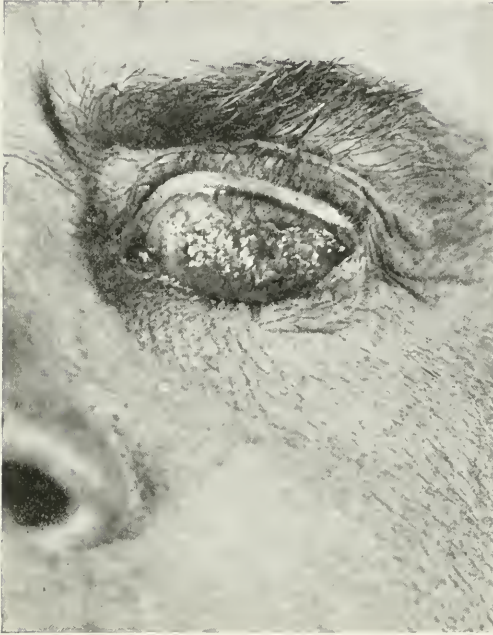
attached to the skin but formed an integral part of the conjunctiva and tarsus. The growth measured 35x25x12 mm. Stained sections showed the specimen to consist almost entirely of pink-staining, almost structureless masses, within which were areas suggesting deposits of calcareous material. Isolated strands of connective tissue were observed about the blood vessels.



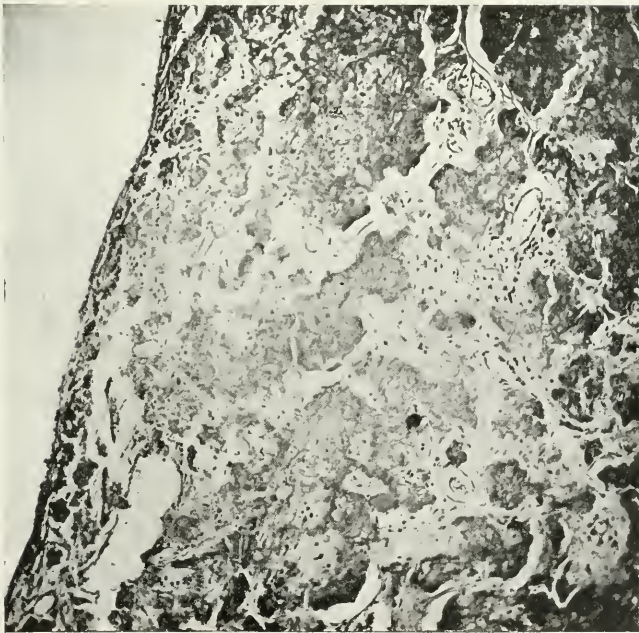
Colloid Tumor of the Eyelid. Before operation. Showing the extreme ptosis of the left upper eyelid and small palpebral fissure. The right eye inturning, with the dense leukoma. (Bedell.)

Cornu cutaneum. This is really a form of cutaneous papilloma, a new-growth rarely observed on the eyelids or their margins. It is usually a solitary horny out-growth consisting of proliferated epithelial cells, corresponding with the horny layer of the skin. These tumors are longitudinally striated and of a brownish-gray appearance, observed only in middle life or in elderly people. See p. 3524, Vol. V of this *Encyclopedia*.

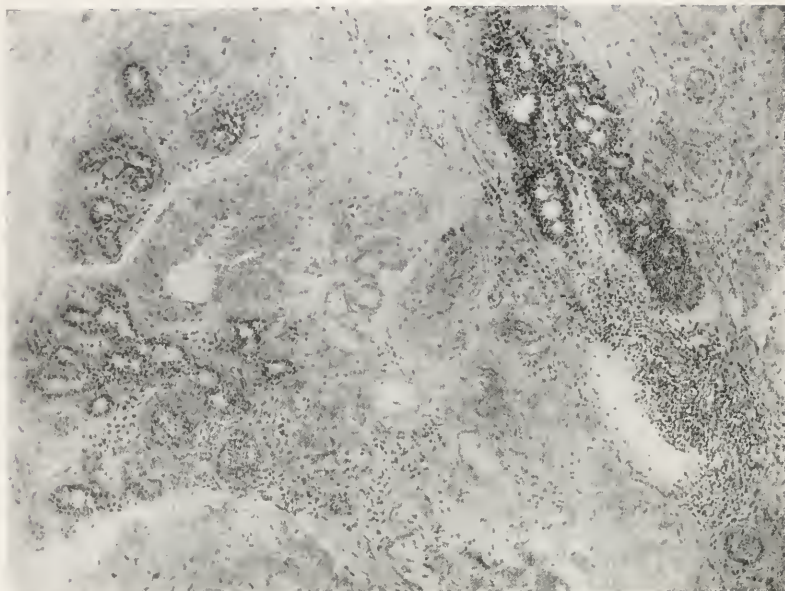
The hypertrophied papillae extend up a short distance, covered by the horny epithelium. The persistence of blood vessels in the papillae within the horny material accounts for their development. The ducts of the hair follicles, sebaceous and sweat glands participate in the process. The growth is slow and if uninterrupted may continue for



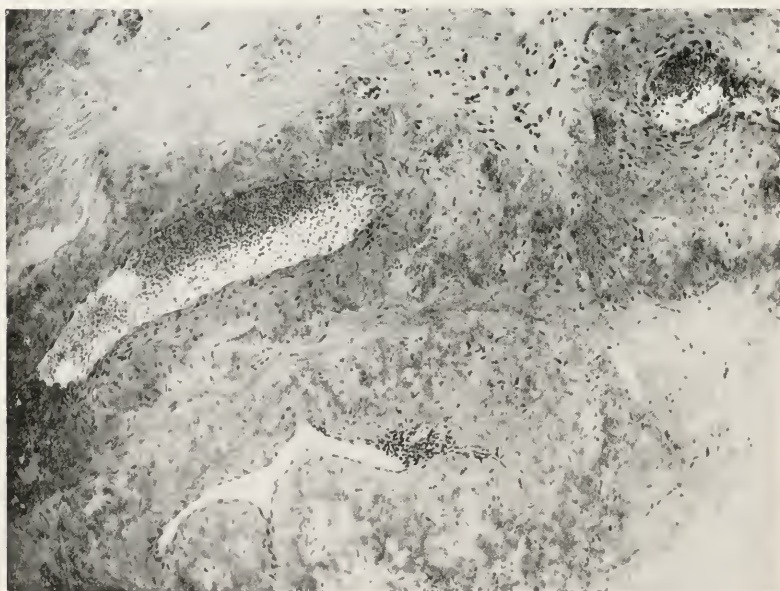
Colloid Tumor of the Lid. Eversion of the upper lid, showing the size of the growth. (Bedell.)



Colloid Tumor of the Lid. Photomicrograph showing atrophy of the conjunctiva and the underlying masses of the amyloid material. (Zeiss Obj. A A, Oc. 2.) (Bedell.)



Colloid Tumor of the Lid. Photomicrograph—Meibomian gland partially degenerated. (Zeiss Obj., A A, Oc. 2.) (Bedell.)



Colloid Tumor of the Lid. Photomicrograph showing vascular changes. (Zeiss Obj. A A, Oc. 2.) (Bedell.)

years. Leber found that carcinoma developed in 12 per cent. of these cases. Excision and canthomy is the method of treatment.

Asher (*Klin. M. für Aug.*, Vol. 52, p. 508) observed in a woman aged 60 years a multiple cutaneous horn of the upper lid. The base of the growth measured $2\frac{1}{2}$ to 3 cm. From the same base, besides several smaller, horny, wart-like excrescences, sprang five large projections of which the longest measured 3 cm. Histological examination showed proliferation of the epithelial cells, with relatively slight papillary hypertrophy. The tumor was abscised and the loss of substance supplied according to Dieffenbach's method by a lateral transplantation of a graft from the temple.

Cylindroma of the eyelid. See this sub-heading under *Sarcoma*; also p. 3659, Vol. V of this *Encyclopedia*.

Cysts of the eyelids. See under **Cysts**, p. 3692, Vol. V.

All types of cysts are not represented in the lids. According to Collins and Mayou's classification the two large groups arising in and about the ocular apparatus may be *parasitic* or *non-parasitic*. The former are exemplified by the cysticercus, hydatid, filaria and various insects, all causing disturbances which are described elsewhere. See **Parasites**.

Non-parasitic cysts of the eyelids vary in the character of their lining. They may be divided as to whether they are derived from (1) cuticular epiblast, (2) neural epiblast or (3) mesoblast. With the exception of lymphatic cysts of the third class we are concerned at present only with the first—those originating from the cuticular epiblast.

Cuticular epiblastic cysts are lined with cuticular epithelium and may be congenital, traumatic, or retention cysts.

Congenital cysts are lined with epithelium having characteristics of the epidermis; *navi*, *dermoids* and *ectatic lymph vessel* formations are illustrations of defective development.

Implantation cysts are of traumatic origin. Misplaced fragments of epidermis or the down-growth of epithelium between the lips of a wound produce cystic tumors. Complete fragments containing epidermis and derma result in a cyst with papillæ, while those with epidermis alone form a pearly nodule or smooth-walled cyst. Hoesch and Aschoff conclude that definite growth of displaced epithelium and cyst formation require that some connective tissue accompany the epithelium.

Retention cysts of the eyelids are observed in association with the glands of this structure. Cysts of Zeiss glands are round, yellowish growths of the size of a millet seed found at the margin of the lids.

The opening of the ducts connected with the eyelashes become closed by hyperkeratosis and these minute cystic bodies result. The limiting membrane of the cyst is of connective tissue and flattened cells, and confines fatty granules, cholesterin and epithelium.

Hordeolum externum is quite different from these cysts in that infection takes place, resulting eventually in true suppuration.

Cysts of Moll's glands. This gland is a modified sweat-gland opening into the follicles of the eyelashes. The growth is a small, transparent cyst seen along the free border of the lid just internal of the eyelash. It contains a clear fluid. Wintersteiner states that cysts arising in the gland itself are multilocular, while those derived from the duct are unilocular. Proliferation of the walls produce more or less solid tumors of an adenomatous or papillomatous character.

Cyst of the Meibomian glands. This is of rather rare occurrence. The gland opening becomes closed either by fibrous thickening or by hypertrophy of the epidermis. The cyst results in the more or less thinning of the tarsus. The contents is composed of coagulum and granular debris. In trachoma there is frequently occlusion of the ducts by cicatricial bands, but here cysts are of comparatively infrequent occurrence, owing to the resistance of the dense fibrous tissue that overlies the tarsus.

Alt (*Amer. Jour. Ophth.*, Vol. xxix, p. 363) describes an unusually large cyst in the lower eyelid of a boy aged 9 years. The cyst, development of which had been noticed for a year, involved a little more than the inner half of the lid, reaching about 4 mm. above the margin and partly covering the pupil. The Meibomian glands were represented by delicate lines on the cyst wall. The growth was dealt with by incision and packing.

Coats (*Roy. Lond. Ophth. H. Report*, Vol. xvii) states that the derivation of a new-growth from sweat glands may be assumed if one or more of the following postulates are fulfilled: (1) if a connection with normal gland tissue can be proved; (2) if the normal gland structure is reproduced or imitated; (3) if characteristic secretion products can be demonstrated. Of these the second is of chief importance; for, as regards the first, a connection with normal gland tissue can rarely be shown when the tumor has attained some size, while in the case of a small new-growth the test would not afford a sufficient distinguishing mark between simple hypertrophies and true neoplasms; moreover, the tumor may truly be "heterotopic," i. e., not derived from normal, fully developed glands, but from embryonal implantations of the same tissue. In the case of sweat-gland tumors the character of the secretion is rarely of diagnostic value, but the

finding of crystals of calcium sulphate, a normal constituent of the sweat, has been recorded by Wintersteiner.

The structure to be expected in a sweat-gland tumor will differ as to whether the growth arises in the secreting tubule or in the duct. The secreting tubule has a double lining, an inner layer of columnar cells with fairly abundant protoplasm, and an outer layer of small nuclein cells close to the basement membrane among the feet of the columnar cells. It has an ill-defined body with apparently very little protoplasm; these latter elements are supposed to be plain muscle cells, though not all observers are satisfied with the proof. The small sweat-glands of the lids, as opposed to the modified glands of Moll, are said to have no outer layer. The duct has also a double lining, but



Cystoma of the Lid. A portion of the wall of one of the cystic spaces, showing the double lining of epithelium—inner layer cubical, outer smaller and less regular. (Coats.)

the cells of the two layers are lower, more cubical, and more like one another. In tumors of the sweat-glands an exact reproduction of these characters is not necessarily to be anticipated, for even in the simplest tumors the formation of cysts, etc., will cause a certain amount of flattening and modification of the epithelium, while in less typical growths there will be some irregularity in the form and arrangement of the cells; but at least in the more typical parts, as Wintersteiner has insisted, the lining should be double, and if the tumor is derived from the secreting portion of the gland, the two layers will be dissimilar. These conditions, it will be seen, are fulfilled in the following cases.

A gentleman, aged about 50, had noticed for a year the presence of a small swelling at the outer canthus of each eye. In an exactly symmetrical position on each side, a little beyond and clear of the

outer canthus, and a little below the external palpebral ligament, are small cystic swellings close under the skin, which is tightly stretched and not movable over them.

In dissecting out the cysts, the right one was pricked and some of the lining membrane probably left behind. Five and a half years later the cyst recurred on this side and was again dissected out. Microscopic sections show a number of irregular cystic spaces, lying in the deeper layers of the corium. The spaces are probably all connected with one another, forming not independent loculi, but a multioocular cyst. The lining epithelium consists typically of two layers, which represent, with very little alteration, the double lining of sweat-gland tubules (see the figure). The situation of the cyst, deep in the corium, and the character of its lining epithelium prove that it was derived from the body of the gland, not from the duct. The observation confirms a statement of Wintersteiner's, that cysts arising in the gland itself are multilocular, while those derived from the duct are unilocular.

Holden (*Tr. Amer. Oph. Soc.*, 1906) presents an unusually interesting pathological report on May's case of microphthalmos in a boy aged 9 months, with an upper-lid cyst. The large tumor, as shown in the cut, lay behind the upper lid and was attached by a narrow stalk from just behind the equator of the globe. During the year following the removal of the tumor the eye ball developed to almost normal size.

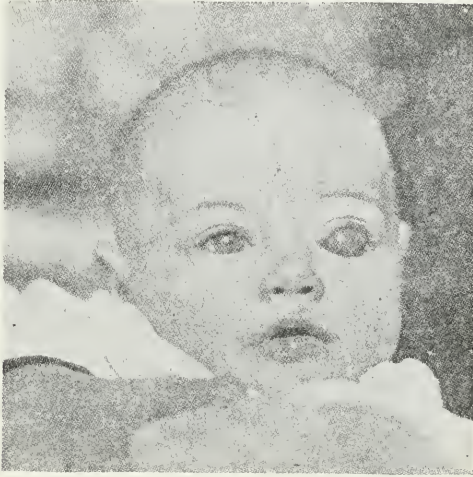
Evidently a knuckle of the secondary optic vesicle forced its way upward into the overlying mesoblast and continuing to develop formed a mass of folded rudimentary retina surrounded by a fibrous sheath continuous with the sclera. On passing from the stalk into the tumor proper the relations of retina, pigment epithelium and outer fibrous coat are modified.

The chief feature in sections of this tumor are numbers of rosette formations similar to those found in gliomas and in some retinæ of arrested development. The principal cells in these rosettes are seen to develop atypically from embryonic cells which in their natural course would become rods and cones.

Dermoids of the eyelids are of rare occurrence. (See **Dermoids**, p. 3841, Vol. V.) They are usually smooth spherical growths varying somewhat in size and having a firm pedicle-like attachment to bone or periosteum. They are freely movable. The most frequent site is the neighborhood of the external canthus, less frequently at the internal canthus, and quite rarely on the brow. They are frequently associated with sutures and fissures which existed during fetal life. At the inner canthus the growth may have a dura mater pedicle attachment simulating a meningocele. This should be borne in mind when ex-

amining or excising growths in this location. Attention is often attracted to them during adolescence owing to the rapidity of their growth. They are always congenital.

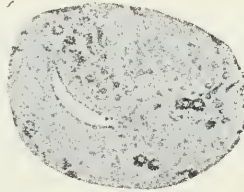
Treatment consists in excision but, if need be, one should be prepared to go far into the orbit.



Cyst of the Lid. Head of the child, with the cyst in the left upper lid. (Holden.)



Upper-Lid Cyst. Natural size. (Holden.)



Cyst of the Lid. The pedicle of the tumor, showing proliferating large cells at various points on its outer surface and numerous rosettes near these points; Nissl stain. (Holden.)

Purtscher (Graefe's *Arch. f. Oph.*, lxxx, p. 251) describes two specimens of dermoid of the upper lid, which were marked by the presence in the lining wall of two distinct kinds of epithelium; the one arranged like epidermis, and the other like mucous membrane.

Calderaro (*La Clin. Ocul.*, Jan., 1908) reports a growth the size of a pigeon egg attached to the lower lid, which was removed in toto



Cyst of Lid. A section through the middle of the tumor. The outer portion connective tissue, the inner rudimentary retina. (Holden.)



Cyst of Eyelid. Large cells growing inward from the outer surface of the retina to form a rosette. (Holden.)

and contained about eight drops of a yellow oily liquid. The fluid contained epidermoid cells in suspension, infiltrated with pigment granules and crystals of cholesterin. The cyst wall was made up of epithelium and connective tissue which represented the dermic chorion. Capillary vessels were wanting but large veins and small arterial trunks were abundant. The cutaneous covering preserved all its usual characters. The epithelium covering the dermoid was made up of cuboid elements.

Alt (*Amer. Jour. Oph.*, p. 9, 1909) reports a dermoid removed from the upper lid of a man aged 18 years. The tumor was made up of three cysts, one of which contained lanugo hair.

Endotheliomata of the eyelid. See this sub-heading under *Sarcoma*.

Elephantiasis of the lid. There is an ill-defined relation between multiple nerve-trunk tumors and certain forms of elephantiasis. The hypertrophy of nerve trunk or filaments associated with lymph stasis and the occasional pigmentary changes in the skin are features which differentiate non-parasitic elephantiasis from fibromatosis. It also possesses a more striking hereditary tendency, while the latter belongs more particularly to fetal life. Early there is a soft thickening; later a firm or sclerosed lid. The lymph vessels are frequently increased, enlarged, or cystic, and diffused over a large area or over the entire lid.

See, also, p. 4279, Vol. VI of this *Encyclopedia*.

Parsons (*Pathology of the eye*, p. 13) and Rockliffe report a case as follows: The upper lid was enormously swollen, the increase in tissue being principally upon the posterior or conjunctival side, resulting in marked ectropion. This increased growth consisted of masses of convoluted nerves covered by inflamed conjunctiva. The nerves were generally smaller than those in the major (orbital) part of the growth, but showed similar hypertrophy of the endo- and peri-neurium. The nerve-fibres, stained by Weigert's method, showed comparatively little change. The other tissue of the lid exhibited more edema and congestion—great dilatation of the subdermal lymphatics being a marked feature.

Fibroma of the eyelids. These tumors are usually small, firm or soft growths suspended from the skin surface by a thin pedicle; occasionally they may form larger rounded nodes involving the subcutaneous tissues. They are circumscribed, encapsulated and usually lobulated. After attaining a certain size they remain stationary. They bleed freely when injured. Secondary changes bring about certain alterations in texture.

Microscopic sections show densely packed fibrous tissue, gelatinous

and hyaline material, and a rich supply of blood and lymph vessels. They show irregularity in size and shape of cells, with increasing proportion of cells to matrix. These tumors also exhibit a tendency to recurrence; hence their name of fibrosarcomata. Borst depends largely in differentiating fibroma from sarcoma upon the irregularity in size and shape of the cells as well as the overgrowth of nucleus and absence of definite stroma. Cohnheim's theory is that they arise from misplaced islands of tissue. Other theories point to local irritation and disturbance of nutrition.

See p. 5006, and on p. 5185, Vol. VII, of this *Encyclopedia*.

Kalt (*Annales d'Ocul.*, March, 1909) studied a fibromatous hypertrophy of the palpebral margin of the upper lid. It was composed of a mass of connective tissue bundles which had become hyaline and were passing into an amyloid condition. In Poulard's (*Bull. de la Soc. d'Oph. de Paris*, March, 1918) case both lower lids presented a number of small, white, nodular fibromas.

In Meyerhof's (*Oph. Rec.*, xix, p. 213) case of plexiform angiofibroma observed in a girl, aged 16 years, the growth had begun six years before as a bluish spot, and in three years had involved the whole upper lid.

Fibroma molluscum. Neuro-fibroma. Recklinghausen's fibroma. This, the most frequent fibroma of the skin, occurs in multiple form and arises from the cutaneous nerve filaments. Recklinghausen in 1882 traced degenerating nerve-fibres in several characteristic cases and stated that all these tumors arise from nerve-trunks or from filaments. They are multiple, from a pin-head to a pea in size; occasionally as large as an apple. They may become so numerous as nearly to cover the entire lid. They are situated just beneath the epidermis, and at times the overlying skin is markedly pigmented, a true *neurofibromatosis*. See p. 5006, Vol. VII of this *Encyclopedia*.

Velhagen (*Cent. f. prak. Aug.*, Feb., 1912) studied, in a woman, at. 60, a pear-shaped mass hanging by a narrow stalk from the edge of the upper eyelid near the caruncle. It was 30 mm. long by 25 mm. wide and had been thirty years in developing. Examined sections proved to be a well-marked example of Recklinghausen's fibroma.

Granuloma of the eyelid is not of as frequent occurrence as it is of the conjunctiva. It is a granulation mass following injury, irritation or ulceration. Granulomata are occasionally observed after chalazion or operation. They are soft, irregular and, at times, smooth masses which may attain considerable size. They bleed easily. They contain giant endothelial and connective tissue cells and are richly supplied with very thin-walled blood vessels. They are partially or wholly

covered by a thin layer of epithelium which projects into the underlying structures, giving somewhat the impression of an epithelioma on section. Upon excising the growth the base should be thoroughly cauterized, otherwise they are liable to recur.

Cosmettatos (*Klin. M. f. Aug.*, 1908) remarks that granuloma is generally regarded as a benign growth; this is true in conjunctival granuloma, but not always in that of the lid margins. He reports an instance in which such a tumor underwent conversion into an epithelioma.

In Wescott's (*Jour. Am. Med. Ass.*, Vol. 66, p. 2067) case, in a boy, aged 9 years, a small tumor, apparently a sebaceous cyst, was first noticed 8 or 10 weeks previously, just above the cilia of the upper lid. The appearance suddenly changed to that of a blood blister which in a few days was so prominent that a silk thread was tied around it. Instead of drying and dropping off, the tumor became infected, grew larger and bled easily when touched. It presented a teat-shaped mass of dark-red color, apparently coming through the skin rather than growing from it, being surrounded by normal integument, as with a collar. A slide showed the growth to be a *granuloma pyogenicum*, pathologically very simple, but clinically very confusing, simulating malignant tumors and chancre.

These cases were first described in 1897 by Poncet and Dor as *botryomycosis hominis*. In 1902 Bodin and others demonstrated that the organisms producing the lesions were not due to botryomyces but to staphylococci. In 1904 Hartzell clearly established the true character of the lesions and suggested the name *granuloma pyogenicum*. Wescott successfully removed the growth by incision.

Gumma of the eyelid. These luetic tumors are composed of endothelial proliferation groups of epithelioid cells, blood and lymphatic vessels, and infiltrated tissues common to many forms of inflammation. Usually there is also a marked increase of connective and fibrous tissue, and the lids become enlarged and firm. Later, the mass degenerates and if near the surface breaks through, producing an eroded, "punched out" ulcer. Upon healing, the periphery of the scar is pigmented. Rodent ulcer, tuberculosis and suppurating chalazion should be borne in mind when making a diagnosis. History of infection and laboratory findings will usually clear up any uncertainty.

See p. 5009, Vol. VII of this *Encyclopedia*.

From a study of recorded cases and from personal observation J. Hutchinson, Jr., arrived at the following conclusions: (1) Late secondary and tertiary affections of the eyelids are met with most commonly in those who have suffered severely from syphilis, especially

those who have had rupial or tuberculous skin eruptions or ulcers of the palate. (2) The upper lid is more liable than the lower one to be affected, though both are not infrequently involved. (3) The tertiary ulceration (gummatous) of the lids is more often met with in women than in men. (4) Not only do many cases of the latter resist specific treatment to a marked degree, but they show a strong tendency to relapse after apparent cure. (5) As a rule syphilitic ulcers and gummata of the eyelids are more painful than those met with in other parts of the skin, partly due to the free innervation of the eyelids and partly to their constant motion.

Pissarello (*Arch. di Ottalm.*, July, 1916) records a case of this rare affection in a man aged 22 years. Acquired syphilis could be excluded.



Gumma of the Eyelids. (Sautter.)

There was a history of a skin disease in infancy, and five years before he came under Pissarello's care he had suffered from a perforation of the palate, which had been successfully operated on. The affection of the eye had been first noticed some five months previously as a swelling with redness which involved both lids of the right eye. When first seen the lids were greatly swollen, and a large and deep ulcer occupied the region of the internal angle and the inner-third of the upper lid and two-thirds of the lower. The edges were sharply-cut and raised, and the base covered by a greyish membrane, which was easily removable. The eye was unaffected, and the vision normal. The submaxillary, preauricular and cervical glands were painlessly enlarged. He had ozena, a depressed nose bridge, and teeth indicative of hereditary syphilis. Microscopical examination of the scrapings from the ulcer showed neither tubercle bacilli nor spirochetes. Intra-dermal tubercle reaction was negative; Wassermann strongly positive. Intensive treatment with mercury and iodide was successful in curing the condition.

Under the title of *syphilitic tarsitis* Sautter (*Ann. of Oph.*, Vol. XX, p. 729), discusses a case. The left upper lid presented a large tumor mass with several shallow ulcerations on the conjunctival surface. The skin was movable. Compression of the lid caused a thick, creamy discharge at the opening of the Meibomian ducts. An incision into the mass was followed by some bleeding but no discharge of pus. The preauricular and parotid region was greatly swollen. Marked improvements followed one administration of salvarsan.

Keloid of the lids. Keloids are classified as spontaneous or traumatic. The former term is applied when it is impossible to establish a traumatic origin. The latter class is the more frequent, occurring as a peculiar hyaline growth of connective tissue in the skin, and following trauma or scarring. They are firm, elevated, or polypoid masses in the scar tissue, slowly progressive until all the scar is involved. Certain individuals show a predisposition to connective tissue overgrowth following burns, scratches, needle punctures or surgical wounds. At times they grow to considerable size. The growth contains blood-vessels, lymph spaces, hyaline material and fibroblasts. In Kalt's case (*Ann. d'Ocul.*, Vol. cxli, p. 189), keloid of the lid margin, there was a small tumor at the margin of each upper lid composed of a mass of connective tissue bundles undergoing hyaline and amyloid degeneration. See p. 5014, Vol. VII; p. 3382, Vol. V, and p. 6743, Vol. IX of this *Encyclopaedia*.

Leiomyomata of the eyelids are single or multiple, small or large, firm or cystic tumors, composed chiefly of smooth muscle-fibers. They are usually circumscribed and with poor blood-supply, their nutrition being effected largely by the lymphatics. They are, therefore, of slow growth; but they may remain stationary or regress. They are frequently subject to fatty or hyaline degeneration followed by calcification. Although usually of slow growth yet they may make rapid progress when there is a sarcomatous transformation. A diagnosis between leiomyoma and a spindle-celled sarcoma is often difficult.

Alt (*Ophthalmic Year-Book*, Vol. vii, p. 301) studied, for Hender-son, a recurring tumor removed from the upper lid of a girl aged 15 years. The growth contained bands of elongated cells with an almost rod-like nucleus, looking like unstriated muscle cells, warranting the diagnosis of a malignant leiomyosarcoma, possibly arising from the muscular coat of the blood vessel. See p. 7189, Vol. IX of this *Encyclopaedia*.

Lipomata, firm, elastic, usually multilobulated and sharply circumscribed growths, are rarely met with in the lids. When present it is very probable that they are secondary to growths in the orbit. This

seems especially so in view of the fact that the skin of the lids is devoid of adipose tissue. The treatment is removal.

Greco (*Arch. di Ott.*, Vol. 21, p. 606) found an osteoma of the orbit associated with angioliipoma of the lid.

See p. 5014, Vol. VII of this *Encyclopedia*.

Lymphomata of the eyelids are really metastatic growths, the conjunctiva and lachrymal glands being the only eye structures containing lymphoid tissue. In the lid they appear as small or quite large growths frequently associated with similar tumors of the orbit. At times they are lobulated (often involving the whole lid) and frequently symmetrical. They contain small, round cells and are difficult to differentiate from small, round-celled sarcoma. Clinically they are variously qualified as lymphadenoma, lymphosarcoma, etc.

See p. 5015, Vol. VII, and p. 7562, Vol. X of this *Encyclopedia*.

The lymphoma of the lower lid reported by De Lavigerie and Onfray (*Ann. d'Ocul.*, Vol. 149, p. 281) was part of a general lymphomatosis in a woman aged 58 years. The lid tumor was the size of a large almond, and appeared as a firm swelling beneath the external half of the palpebral conjunctiva, which was normal. There were a number of small tumors beneath the skin of the face, and in the soft palate. There was a history of multiple tumors dating back three years, with temporary improvement from time to time. Repeated examination of the blood pointed to a marked and progressive anemia, without leukemia or abnormal leucocytic forms. An excised portion of the lid tumor showed the characteristic structure of lymphoma. The patient died a few months later in cachexia.

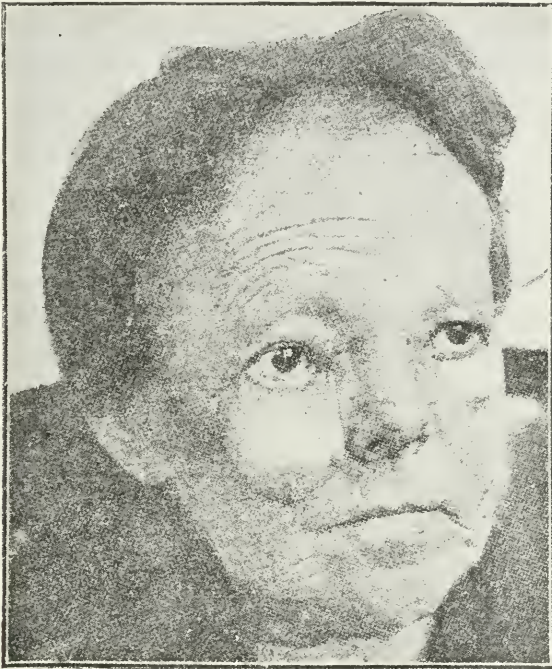
Demaria's (*Bol. Soc. de Oft. de Buenos Aires*, Vol. 3, p. 44) patient, a woman aged 30 years, had symmetrical lymphomata. One year following removal the same condition, but more pronounced, was present. Complete cure resulted from the application of 10 mg. radium bromid every four days for a period of two months. Sections showed a delicate reticulum containing within its meshes rounded lymphocytes.

Levitskaya (*Viestnik Ophth.*, Vol. 32, p. 415) reports on an extensive lymphoma of the cul-de-sac of the upper eyelid, penetrating into the orbit.

Rund (*Ophthalmoscope*, X, p. 670) studied a growth from the upper lid of a man aged 51 years. It had appeared seventeen years earlier, and twice recurred after excision. Microscopic section showed it to consist almost entirely of plasma cells. There was absolutely no indication of a chronic inflammatory process. Plasma cells were found arising not only from the blood vessels next the growth, but around vessels at some distance from it. The tumor is therefore to be regarded

as analogous to a lymphoma, and the author gives it the name of *plasmocytoma*.

Lymphangiomata, of mixed lymphatic and vascular origin, present an enlargement of the eyelid and are frequently associated with similar growths of the conjunctiva. They vary in size from that of a pea to a considerable mass, and are tense, yet easily compressible, resembling cysts. The cavernous spaces are separated by a single layer of endothelium and a small amount of fibrous tissue. The contents is



Lymphangiectasis of Lower Lid. (Jessop.)

a coagulum or hyaline material. In obtaining microscopic specimens care should be exercised to avoid contamination of the contents by blood, as it is frequently the only method of making a definite diagnosis. They are probably congenital in that the predisposing factors are present at birth. The large cavernous type is rare. The treatment is the same as in *hemangioma*.

de Jong (*Kl. Mon. f. Aug.*, Jan., 1908) observed an instance of diffuse lymphangioma affecting both the conjunctiva and upper lid. A study of these cases makes for the assumption that tumors of this nature are, in part at least, dependent upon a congenital predisposi-

tion, an opinion suggested by Axenfeld and Kapp. These authors consider lymphangioma of the orbit as teratoid formations. According to the researches of Axenfeld, independent lymphatic vessels are not found in the orbit. This view is strengthened by a case of Wintersteiner who found the tumor to contain true lymphatic follicles; and these are normally foreign to the orbit.

Jessop (*Proc. of Royal Soc. Med., Sec. Ophth.*, Dec., 1914, p. 5) describes a case of lymphangiectasis of the lower lid of about the size of a small orange, in a female, aged 51 years. The swelling was of two years' duration. The general characteristics of the swelling, which was in most of its extent semi-fluid to the touch and which pitted readily upon pressure, are shown in the accompanying figure. The skin covering the mass was smooth from distention. The upper eyelid had recently become edematous; and some thickening and edema had made its appearance in the temporal region. Ophthalmoscopic appearances were normal, and vision 6/6. Skiagrams showed no changes in the bones or sinuses. The tumor was removed, and on cutting into it, the skin surface was found to be thickened and a central cavity, which was lined by endothelium, to contain a blood-stained serous fluid.

Alt (*Amer. Jour. Ophth.*, 27, p. 330) removed a *lymphangio-endothelioma* from the lower lid of a woman aged 60 years. A cyst, which had existed for years, had been removed from the same locality six years previously. Microscopically there were rows, patches and in places rings of epithelium-like cells distributed irregularly in a transparent, almost unstained, evidently edematous connective tissue. The few blood vessels present were almost completely ensheathed by these cells.

Uhthoff's (*Klin. M. für Aug.*, Vol. 57) patient with lymphangioma had a tubercular lesion of the conjunctiva. In the case reported by Levitskaya (*Viestnik Oph.*, Vol. 32, p. 415) the growth penetrated into the orbit. Hirschberg (*Cent. f. pkt. Aug.*, Jan., 1906) studied a congenital lymphangioma; Mutterlein (*Leipsic Thesis*, 1914) describes a cystic lymphangioma.

Milium. Sebaceous cyst of the eyelid. This is a small, round, pearly-white or yellowish-white elevation on the eyelid. It is a retention cyst of a sebaceous gland and the contents are horny or fatty epithelial cells. The cause is usually improper care of the skin, but the growth may depend on some constitutional disturbance attended with faulty elimination. The cyst should be opened with knife or needle and the contents evacuated. See p. 3693, Vol. V, and p. 5107, Vol. VII of this *Encyclopædia*.

Molluscum contagiosum. Molluscum verrucosum. Molluscum se-

baceum. Epithelioma contagiosum. This variously named tumor occurs as a small, rounded, umbilicated mass, at first sessile and waxy looking, later yellowish and pedunculated. It is observed most frequently in children. Upon pressure a substance, composed of molluscous, degenerated cells, is evacuated. It is a hyaline degeneration, with swelling of the cells, forming a homogeneous mass. See also this caption on p. 7849, Vol. X.

Parsons (*Pathology of the Eye*, Vol. 1, p. 15) gives the following description of this growth: "In vertical sections the tumor consists of wedge-shaped lobules, separated by thin fibrous septa, and enclosed, except on the surface, by a fibrous capsule. The border is continuous with the epidermis. Each lobule is bounded by palisade epithelium, and round nucleated epithelial cells adjoin this." Molluscum bodies may be observed in the process of extrusion through the lobule orifice.

The disease is contagious, but is probably due to an organism whose nature has not been definitely determined. *Treatment* consists in pressing out the contents of the tumor, then touching it with silver nitrate, trichloroacetic acid; or employing Clark's method of desiccation.

Other papers on the subject are by Lauber (*Zeit. für Aug.*, Vol. 30, p. 246); De la Torre (*Arch. de Ottal. Optal. Hisp.-Amer.*, p. 275); Terson (*Rec. d'Oph.*, July, 1906); Oppenheimer (*Ophthalmology*, April, 1905).

Nævus pigmentosus. *Pigmented mole* is an oval or round, flattened elevated, single or multiple, congenital growth. A frequent site is the upper lid, side of the face, or cheek. It may be hairy, warty, or smooth; varying in size from a pin-head to a large mass.

See, also, p. 7849, Vol. X and **Nævus, Ocular**, p. 8282, Vol. XI of this *Encyclopedia*.

The natural history of the vast majority of pigmented nævi includes a long period of slow growth; then a stage of inertia followed by a process of regression. At least a congenital disturbance in the derma is present, and in many instances the mole is visible at birth. Those appearing in early life, according to Unna, always show evidences of progressive growth. In the congenital mole of infants the early stages of development are evident; the process being limited chiefly to the epidermis and the nearby derma. The epithelium of the hair follicles and sweat glands often participate in the process. Pigmentation usually accompanies these early changes, but may be absent. In adults, many moles may be elevated, warty or papillary, with scanty blood- and lymph-vessels. Fibrous regression affects many moles in their late history. Occasionally malignant changes supervene—usually in deeply pigmented growths—a mysterious feature observed in some

apparently innocent tumors. The large ones should be excised; the smaller ones may be treated by electrolysis or desiccation.

Pooley (*Tr. Oph. Soc. U. K.*, Vol. 35, p. 226) reports a patient aged 70 years, with a pigmented, hairy mole involving the eyelids and conjunctiva and extending to the face and neck and to the roof of the mouth on both sides. At the time of observation the condition was advancing, particularly at the lid margin, at which point there was considerable pigment. The question of beginning malignancy was considered.

Risley (*Sec. Oph., Col. Phys., Phila.*, March, 1908) effected an almost complete cure in one of these tumors of the lid by a single application of electrolysis. Both needles were thrust into the growth, close to its base, about 3 mm. apart. Poulard and Canque (*Soc. d'Oph. de Paris*, p. 55, 1909) also describe a case.

Nævus vasculosus is a growth allied to the foregoing. It is usually of port-wine color, and appears as a circumscribed or diffused dilation and new-growth of superficial capillaries and venules of the derma. The overlying epidermis is usually thin and delicate. These neoplasms are usually congenital, affecting both the eyelids and face; consisting of a simple telangiectasis of venous capillaries. The deeper congenital nævi have often been the source of extensive plexiform and cavernous angiomas but, according to Unna, are to be distinguished from true angiomata. See **Nævus, Ocular**, p. 8282, Vol. XI of this *Encyclopedia*.

Ziemssen (*Cent. f. p. Aug.*, Vol. 38, p. 72) observed a gigantic vascular nævus in a man aged 81 years. It extended from the right parietal bone across the right side of the forehead, temple, and cheek to the right side of the upper lip. The upper and lower lid of the right and, in part, the left side of the nose, were also involved. This extensive angioma was said to have been present from early childhood. Krailsheimer (*Klin. M. für Aug.*, Vol. 52, p. 139) reports a case of vascular nævus which had been present for 10 years on the upper lid; at the end of which period the growth showed a tendency to increase. Excision was followed, years later, by a relapse. Attempts at electrolysis having failed, an excellent cosmetic result was obtained by carbon dioxide snow. Two slight subsequent relapses were easily excised. No relapse had occurred in two years, and the cicatrix was almost invisible. The same author reports two cases of cavernous angiomata upon the lower lids of two male infants.

Neuroma is a term which should be limited to a neoplasm of new-formed nerve-cells and fibers, usually referred to as a *ganglionic neuroma*. Ganglion cells and their processes, although an example of

highly differentiated soft tissue, display a surprising power of growth, the cells developing into new growths and the fibers multiplying to an extent closely approaching a neoplasm. While it is a fact that in certain instances true new formations of nerve tissue do occur, yet the majority of these growths are false neuromata. See p. 5019, Vol. VII and p. 8360, Vol. XI.

Krauss (*Ber. der Oph. Cong.*, Heidelberg) records a case of *ganglio-neuroma* of the lid, a heretofore undescribed condition. The tumor was a small node composed of isolated strands surrounded by a connective tissue capsule. Delicate connective tissue septa coursed through it and gave to the tumor a lobulated appearance. There was a striking number of ganglion cells characterized by a great variety of sizes, forms, coloration, pigmentation; and a number of nuclei. The cells were surrounded by a connective tissue capsule and presented single processes. Extensive changes in the nuclei and in the protoplasm, with vacuolation, suggested a degenerative process.

E. Scimemi (*Annali di Ottalmologia*, 1905, pp. 329-360) observed 3 cases of *plexiform neuroma of the eyelids*, and describes the details. He also found records of 39 cases of plexiform neuroma of the upper lid in the literature. The personal case was a true congenital neuroma, involving the left upper eyelid of a girl of 13, who exhibited defective development of the outer margin of the orbit, with exaggerated development of the external genitals and stenosis of the ostium of the vagina. On palpation, the tumor gave the impression of being formed of cords and knots. On microscopic examination it was found to be composed of strands of connective tissue; as a rule, they ran in a direction parallel to the fibers of the orbicularis. Most of these cords showed in their center a bundle of nerve fibers.

Neurofibroma. Plexiform neuroma. This is a rare new-growth developing from the fibrous elements of the sheaths of nerves, but with no new development of nerve fibers. The thickening of the nerves in some instances is so great that the lids become markedly enlarged from hypertrophy of the connective tissue. This form of neoplasm is either congenital or appears shortly after birth, developing slowly and continuously. While not a malignant growth it will return if not removed completely. When localized it is inclined to show hard, well-defined nodules generally occurring along the nerve branches. When diffuse, the growth is inclined to be soft, with cordlike convolutions (nodular and fusiform) to which the term *plexiform neuroma* is given. In certain instances it may become so large as to form an overhanging mass, thus preventing elevation of the lid sufficiently to see. These new growths show a distinct partiality for the upper lids. They are

not always confined to the lids but may extend into the conjunctiva, orbit, optic nerve, and even involve the brain. Certain intraocular involvements of the sclera and uveal tract have also been observed.

See, also, p. 10260, Vol. XIII, as well as p. 8330, Vol. XI of this *Encyclopedia*.

According to Collins and Mayou, the affected nerves show an increase of both peri- and endoneurium, the nerve fibers themselves being unaffected. Microscopic specimens show thickened corium, subcutaneous tissue with thickened nerves, thickened perineurium and nerve fibers in masses of thickened fibrous tissue.

Fehr (*Cent. für p. Aug.*, Vol. 37, p. 233) reported four cases of *neurofibromatosis*. Two of these presented, respectively, bilateral optic atrophy and subsiding papillary edema, and were the only ones showing ocular changes out of five cases of general neurofibromatosis examined. In another case several operations were rendered necessary. The body was covered with hundreds of soft fibromata. The palpebral fissure was greatly displaced down and out, the skin of the left brow, of the bridge of the nose and of the left eyelids being transformed into a soft, flabby, pendulous tumor, containing knotty thickenings. The eye itself was normal.

Fehr's fourth case is of exceptional character. For fifteen years a man, aged 38 years, had been affected by multiple neurofibromatosis. Violent headaches, migrainous attacks and slight visual disturbance were followed by an optic neuritis with venous stasis, and the patient became firmly persuaded that he was developing an intracranial tumor.

But the other eye was entirely normal, and he was assured that the condition was limited to the orbit. The vision of the eye became almost lost, and the patient insisted on an exploratory Krönlein operation, which, however, revealed nothing abnormal. Some months later enucleation of the eye became necessary in consequence of hemorrhagic glaucoma. Fehr feels that the ocular changes must have been due to compression of the central retinal vein by a minute orbital neurofibroma.

Röhmer (*Arch. d'Ophthal.*, 31, p. 451) observed a case, the first observation of which was published by Gross, in 1882, under the title "Elephantiasis of the eyelids." The patient was a man, aged 18 years, who had for twelve years noticed a tumor in the region of the right eye, which was gradually increasing in size. The upper lid was almost as thick as a fist at the time of the first examination. A fairly large piece of the tumor was excised, when the patient disappeared from observation. Twenty-three years later he came under Röhmer's care. In the meantime the tumor had attained considerable size and

the general condition of the patient was bad. The tumor had spread far over the adjacent portions of the head and face, and the lids, which were of the size of small oranges, covered the eye so closely that it could not be seen. Fifteen days after an extensive excision of tumor tissue, attended by a great loss of blood, the patient died with symptoms of septicemia and broncho-pneumonia. The microscopic examination showed that the tumor was a neurofibroma which had primarily developed as concentric nodules about the nerves, and after degeneration of these had caused further trophic changes in the skin and bones of the neighborhood.

Fischer (*Arch. f. Aug.*, Vol. 60, part 4) reports a case of *plexiform neuroma* or fibromatosis of the sheaths of the nerves of the eyelids. The patient was aged 24 years, the growth was congenital, and it had been operated on twice. A more extensive operation gave a good cosmetic result, but there remained some diplopia and neuralgic pain of the parts. Marx (*Zeits. f. Aug.*, June, 1908) records a case, seen in a man aged 24, who was stung on the upper eyelid by a wasp, when 11 years old. The swelling of the lid had continued, and the tumor increased in size, since a blow upon it the year before, and had extended to the brow. The patient's sister had suffered from plexiform neuroma of the thigh. Excision followed by an operation for ptosis gave a good result.

de Schweinitz (*Trans. Amer. Oph. Soc.*, 1891), under the caption of *neuroma of the upper lid and adjacent temporal region*, discusses a case of plexiform neuroma. The tumor was observed in a man aged 20 years. It was present at birth, and since then had not materially changed in its appearance except by its expansion with the corresponding growth of the tissues in which it was situated. The distance from the edge of the brow to the lower margin of the swollen eyelid was 7.5 cm.; the longest transverse diameter, i. e., from commissure to commissure, 9 cm., and the thickness varied from 1 to 1.5 cm. The temple tumor extended from the outer commissure to the ear, and from the margin of the hair to the zygoma. The skin over the area of the growth was slightly brown in color, a pigmentation which had developed since the birth of the patient. To the palpating fingers the underlying mass gave the impression of a somewhat lobulated, slightly-corded growth.

Three operations were performed: first removal of the growth; second the correction of ectropion; third a Panas operation for ptosis. In addition to hypertrophy of the glandular structures in the skin and of the connective tissue, the most marked pathological lesions are large masses, which in cross section appear as concentric whorls of soft tissue, containing in their center more or less degenerated nerve fibers.



Neurofibroma of the Right Upper Eyelid and Adjacent Temporal Region.
(de Schweinitz.)



Neurofibroma of the Right Upper Lid. After operations. (de Schweinitz.)

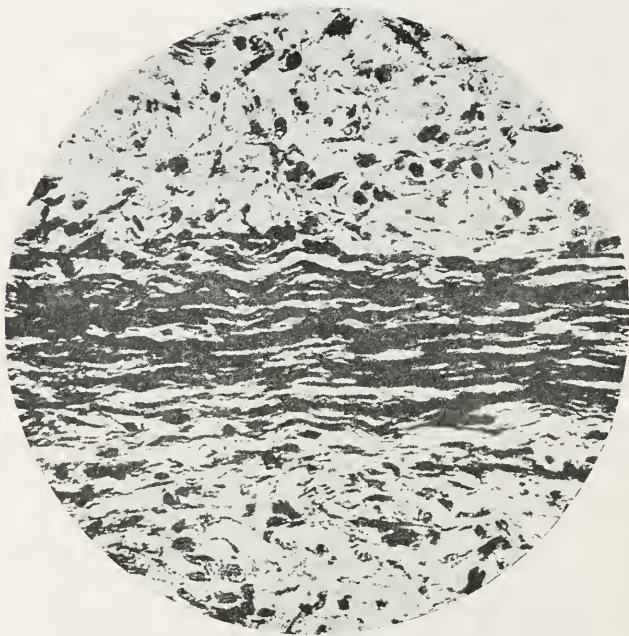


Neurofibroma of the Upper Lid. (de Schweinitz.) Section of the tumor, showing the concentric whorls. [$\times 125$.]



Neurofibroma of the Upper Lid. (de Schweinitz.) Vertical section of the skin of the eyelid, showing hypertrophied gland and dilated lymph spaces.

Odinzow (*Klin. M. für Aug.*, Vol. 21, p. 371) published a case in which the growth had appeared six years previously; and, aside from its weight the mechanical interference caused by the nasal half of the lid hanging over the fissure, occasioned no discomfort. Microscopically the perineurium was principally involved and was undergoing mucoid degeneration. The nerve fibers were largely degenerated, their sheaths containing many Lautermann constrictions.



Neuroma of Upper Lid. An oval whorl, showing a band of medullated nerve fibres passing through its centre. [$\times 250$, Weigert's stain.] (de Schweinitz.)

In Nicoli's (*Ophthalmoscope*, p. 849, 1909) case the lids were so tumefied by the new formation that the patient was unable to open them. The tissue was in the form of strands, which extended under the skin of the forehead and disappeared under the scalp. Total extirpation of the strands was attempted, but there was a recurrence. The growth was made of fibers resembling nerve tissue.

Marchi (*Ann. di Ottal.*, 39, p. 65) observed a *plexiform neuroma* in the outer half of the upper lid of a child aged 6 years. It was adherent to the tarsus. Histologically, there were found hypertrophy of the nerve fibers, fibromatosis of the nerve fibers with proliferation of

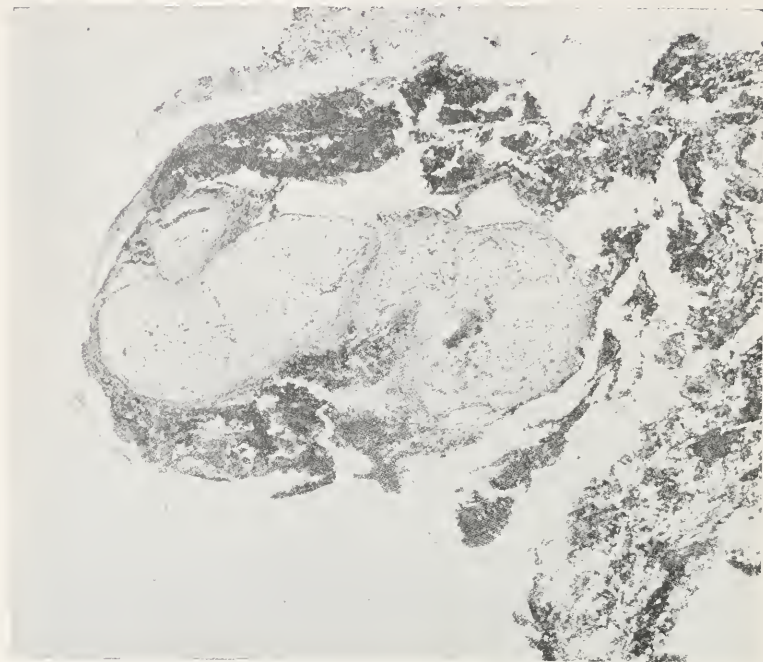
the connective tissue from the perineurium and endoneurium, and signs of degeneration in the nerve fibers.

Knapp has reported the successful removal by a Krönlein operation, of a *plexiform neuroma* of the eyelid which extended to the apex of the orbit. A female, aged 18 years, first showed evidence of a swelling of the lid after a fall at the age of nine months. Operations had been performed on the lids by different ophthalmic surgeons, at the ages of two and one-half, five, twelve, and fifteen years.

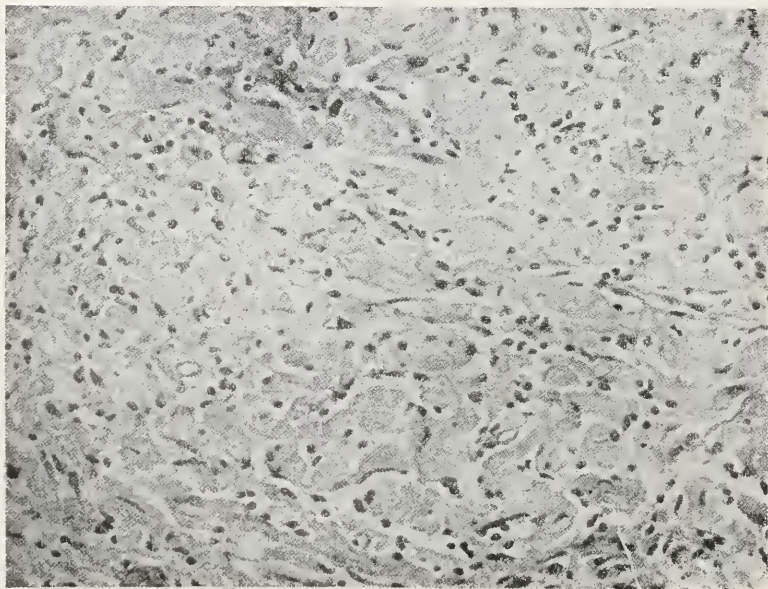


Neuroma of Upper Lid. Small, oval whorl, showing in its centre a patch of medullated nerve fibres. [$\times 125$, Weigert's stain.] (de Schweinitz.)

The tumor measured 22x12 mm. It was soft, and the cut section looked like a myxomatous gland. Microscopically, it showed the structure of a neurofibroma (see the figures). At the periphery normal and degenerated medullated nerve-fibers were present. As one of the previous operations had been performed at the same hospital, some of the tumor which was removed from the eyelid was available and new sections were stained. Sections of the tumor removed at a previous date showed centrally-placed medullated nerve-fibers and the other characteristics of the main growth as it occurs in the eyelid. (See the figure.)



Plexiform Neuroma of the Eyelid. (Knapp.)



Neurofibroma at the Apex of the Orbit. (Knapp.)

Komoto (*Klin. M. für Aug.*, June, 1909) adds a case of *neurofibromatosis with buphthalmos* to the scant literature of the subject. The patient, a boy aged 9 years, first showed swelling of his lids in his third year, and at this time the eye was found to be blind. The child's head was uniformly enlarged, and the left side of the face thickened. There was a diffuse swelling of the tissues about the left orbit, which on palpation was found to contain hard fibres of the thickness of the little finger. The lid drooped because of its weight and size. The implicated orbit was larger than its fellow and its margin thickened. A section of the skin of the upper lid showed an increase in all the dimensions. The subcutaneous nerves had greatly increased in number and size. In cross section some were round, some oval and others irregularly oval. The connective tissue sheath was greatly thickened, while the nerve fibres had more or less disappeared. The remaining fibers were thin and showed some cylindrical swelling. The endoneurium showed concentric overgrowth. In the midst of the connective tissue strands fine nerve fibers ran more or less parallel to one another. Braunschweig (*Kl. Mon. f. Aug.*, Feb., p. 179) saw this growth in a girl aged 5 years. Rosenmeyer (*Cent. für pkt. Aug.*, Mar., 1906) and Sachsaler (*Arch. of Oph.*, Mar., 1906) have each contributed case reports and a discussion of *plexiform neuroma with hydrophthalmos*.

Papilloma of the eyelid. See **Verruca**; also p. 2534, Vol. V; and p. 5019, Vol. VII of this *Encyclopedia*. *Perithelioma of the lid.* See same subheading under *Sarcoma of the eyelid* herein; as well as p. 9612, Vol. XII of this *Encyclopedia*.

Rhabdomyoma. This neoplasm, made up of *striated muscle*, is of rare occurrence in the eyelids. They usually occur in early life; some are congenital, a few have been noted in advanced life. They may be single, or multiple; nodular, flat, or rounded; circumscribed or diffuse. They are usually soft and upon section appear grayish, presenting parallel bundles of intertwining strands of striped muscle fibers. The stroma is adult or embryonal connective tissue (sarcomatous or myxosarcomatous) and found in teratomas, bone, cartilage, etc. Blood vessels are abundant. In certain growths it is difficult to differentiate the type of muscle fiber. The neoplasm pursues a progressive course; in the sarcomatous form it is rapid. The more adult type tends to encapsulate, but the embryonal infiltrates surrounding tissues. Hyaline or amyloid changes may occur. The malignant forms produce metastases. During the past seventeen years but one such neoplasm of the eyelid has been reported. See p. 11427, Vol. XV; as well as p. 9186, Vol. XII of this *Encyclopedia*.

Schnaudigel (*Graefe's Arch. für Oph.*, Vol. 74, p. 372) removed

from the lower lid a tumor that externally looked like a chalazion; but the growth was surrounded by a capsule. Histologically it was a *rhabdomyoma*, benign in character, but there was a recurrence eighteen months after removal. The secondary growth reached a size of 20x17x7 mm. Its general characteristics corresponded precisely with those of the original growth, of which it is assumed a small portion must have been overlooked at the first operation.

Sarcoma of the eyelids. Primary sarcoma of the lids is usually said to be rare, yet reported cases offer no exact knowledge of its comparative frequency. de Schweinitz and Shumway (*Tr. Sec. Ophth., Col. of Phy., Phila., Feb., 1911*), brought the collected number of studied cases by Wilmer (*Tr. Amer. Ophth. Soc., 1894*); Veasey (*Ibid., 1899*); Friedenwald (*Ibid., 1900*); and Alling (*Ophth. Rec., June, 1907*) to eighty. See p. 11544, Vol. XV; as well as 5022, Vol. VII of this *Encyclopedia*.

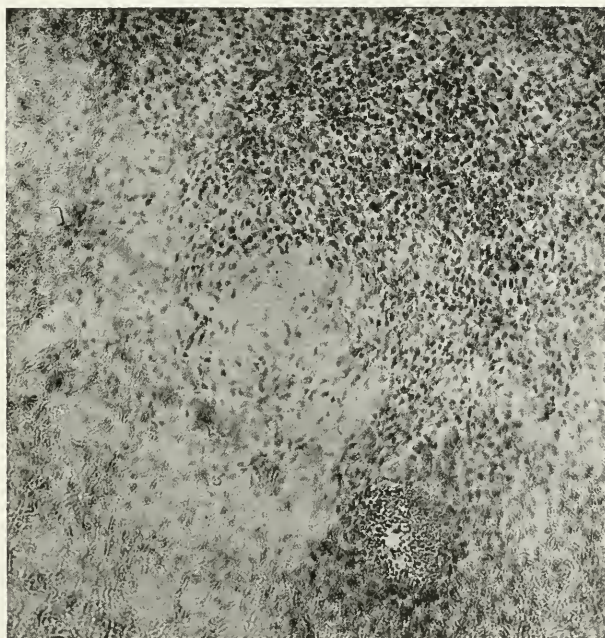
Sarcoma is a malignant growth of vascular, soft or fleshy, fungating character. There is a strong tendency to restrict the term; for many tumors once interpreted as sarcomata have proven to be of epithelial origin. Future investigation of all these neoplasms will doubtless show more definite etiologic, histogenic and clinical facts.

The growth is mesoblastic, and may arise from any of the structures of the lids excepting the epithelial tissues. Some spread from the conjunctiva and nearby structures and, though not frequent, some are in reality primarily orbital. In most instances the origin of the tumor is easily recognized by the presence of cartilage, bone, fat or cellular connective tissue. The growth of these neoplasms is usually rapid, their abundant blood supply favoring rapid cell proliferation. The tendency is to expand locally rather than to infiltrate the tissues. Thus they are fairly well circumscribed although they are usually without a capsule. Their apparent size is frequently increased by the local edema or the hemorrhage induced. As a rule they attain a certain size, then the circulation fails, degenerative changes set in, and further growth depends on their capacity to infiltrate or produce metastases.

Sarcomata have been subdivided histologically according to the type of cell predomination; *round-celled* (43 per cent.), many of which Parsons believes are lymphomata; *spindle-celled* (40 per cent.), *giant- and mixed-cell sarcoma* (17 per cent.). Perhaps fifty per cent. of cases are pigmented. Collins and Mayou recommend what they regard as a more satisfactory classification, based on the type of mesoblastic tissue which the growth simulates; hence the terms *endothelioma*, *perithelioma*, *cyliodroma* and *lympho-, fibro-, osteo-, osteomyeloid-*



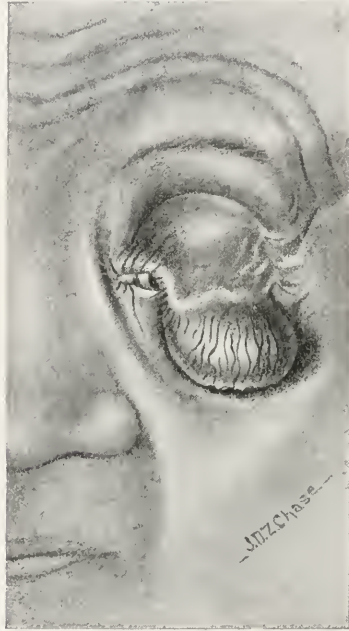
Myxosarcoma of Lid. Weight, 247 grams; size, 10 x 8 x 6 cm. (de Schweinitz.)



Photomicrograph of Myxosarcoma of Lid. (de Schweinitz.)

and *myxosarcoma*. The nomenclature that describes the shape of the cells is reserved by the writers for the growths of a more rudimentary type.

de Schweinitz (*Tr. Amer. Ophth. Soc.*, Vol. 14, p. 341) observed, in a boy, aged 4 years, a *myxosarcoma* attached by a pedicle to the under surface of the upper lid. Protruding through the palpebral fissure was a large, friable mass, resembling granulation tissue, reddish-yellow in color and bleeding freely. The growth had been previously excised and the base twice cauterized; each operation being followed



Round-Cell Sarcoma of Eyelid. (de Schweinitz.)

within a few days by rapid recurrence. At the time of observation a radical operation was advised but declined by the parents. Four months later the child died. The post mortem growth weighed 247 grams: its size was 10 by 8 by 6 cm.

From de Schweinitz and Shumway's (*Tr. Ophth. Sec., Col. Phy., Phila.*, Feb., 1911) study of all recorded cases (80 up to 1911) they found that the age of the patients varied from 10 months to 82 years. The authors reported the removal of a round-celled sarcoma from the lid of a woman aged eighty-one. There was no recurrence after one year; at which time the patient died from pneumonia. The mass

was 4 cm. by 3.75 cm. It hung down over the cheek and was attached at a point between the tarsus and skin.

Pooley (*Proc. Roy. Soc. Med.*, June, 1913), has recorded the case of a woman, aged 65 years, who presented an oval, pedunculated swelling on the upper lid, mobile on the deeper structures, and not firmly fixed to the skin over it. It extended up on the forehead, and backwards into the orbit. It was elastic to touch, and pseudofluctuant. At operation it was found to be encapsulated, and was easily removed. The tumor was examined by Beattie, and found to be a very definite *myeloid sarcoma*. A little more than a year later there was a recurrence in the orbit, which was then exenterated. In another year, the growth recurred in the scar on the forehead. This was removed, and there had been no further recurrence. Pooley has seen two other cases, one Grimsdale's the other Pouled Wells'. All these three cases have been in women of later middle life, have commenced in the centre of the upper lid, and have been definitely encapsuled.

Blok, D. J. (*Tydschr. V. Geneesk.*, Jan. 21, 1905), demonstrated a section of a pea-sized *angio-sarcoma of the upper lid*, which developed directly after removal of a pin-sized sebaceous cyst of the margin of the eyelid in a 15-year-old boy. After excision the wound was cauterized, and patient cured until report (three-fourths of a year).

Claiborne (*Ophthalmic Record*, June, 1907) observed a boy, aged 13 years, with a red tumor the size of a small peanut on the skin surface of the lid. It was pedunculated, corrugated and bled to the touch. The excised growth proved to be an *angiosarcoma*.

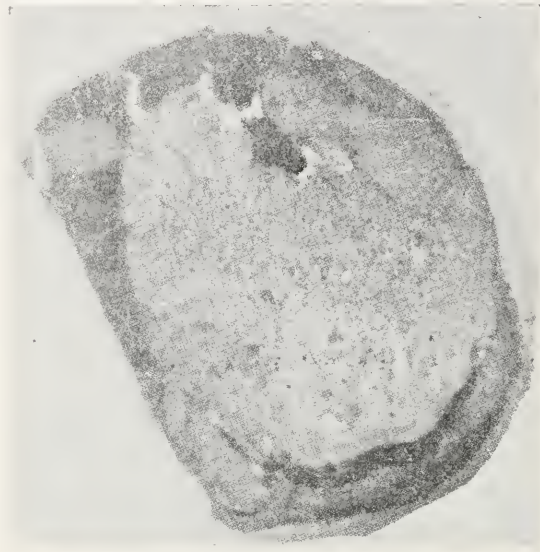
Johnson (*Arch. of Oph.*, Vol. 46, p. 367) did a complete removal, with no recurrence in two years, of an extensive *squamous-celled sarcoma* of ten years' duration.

Veasey (*Phila. Med. Jour.*, Nov. 25, 1899) found in the literature thirteen cases additional to Wilmer's already recorded thirty-five cases of *primary sarcoma of the lid*. The author's case-report is of a growth observed on the upper lid margin of a man aged 45 years. It had been present for about four months and presented the general appearance of a chalazion, except in color, which was that of diluted claret. The mass was adherent to the skin but free of the tarsus. It was resected without difficulty, and found to be exceedingly hard and encapsuled. It measured 7 by 10 mm. The whole mass consisted of spindle cells with oval nuclei. There was a very small amount of intercellular substance; while blood vessels were large channels whose walls, formed

TUMORS OF THE EYE

by the cells of the growth, were lined by a single layer of endothelial cells. The diagnosis was spindle-celled sarcoma.

Paulina Satanowsky (*Semana Médica*, p. 600, Nov. 13, 1919; *Journ. Am. Med. Assocn.*, Mar. 20, 1920) reports a case of *palpebral melanic*



Angiosarcoma of the Eyelid. (Claiborne.)



Angiosarcoma of the Eyelid. (Claiborne.)

sarcoma that had grown from the conjunctiva of the upper lid, and it was successfully removed by Cisneros's *electro-coagulo-ignicion* method, charring a circle of tissue all around the tumor and thus preventing hemorrhage. There were several papillomas on both the upper and lower lid, and all were burnt off by this same method. The

sarcoma had developed to a size of 10 by 13 mm. in less than a month after it had first been discovered.

C. G. Darling (*Trans. Chicago Oph. Soc.*, May, 1920) has reported a case of *round-celled sarcoma of the lid*.

"A boy of eight years, of Italian parentage, entered my service at County Hospital May 11, 1918. The right eye had been twice operated on; an excised specimen had been examined and was diagnosed as round-celled sarcoma. The growth was returning and the doctor advised radium treatment.

"A history of a blow on the eye with an eraser a few months previous was obtained, only slight pain at the time and no interference with vision. The pain had been growing more severe and was constant of late. Family history negative. Previous illness—diseases of childhood only. Neck; a few anterior cervical glands enlarged. Chest expansion equal and symmetrical. No râles. Heart, abdomen and extremities; negative. X-ray of skull; negative. Wassermann; negative. Examination of the right eye showed the upper lid drawn upward and toward the inner canthus, causing a slight ectropion. The upper lid was thickened and reddened and above the inner canthus there was a hard, infiltrated, tender mass about a centimeter and a half in diameter which seemed to be adherent to the margin of the orbit. The conjunctiva of both eyes was injected and there was a slight chemosis of the nasal half of the bulbar conjunctiva of the right eye. Cornea, iris and fundus; normal. The eye was displaced slightly to the temporal side; movements in all directions free. A small specimen was removed from the lid and sent to the laboratory for diagnosis. On account of the displacement of the eye and the chemosis of the nasal half of the bulbar conjunctiva, an exenteration of the orbit with removal of the lids was decided upon.

"The operation was done June 6, 1918. No involvement of ethmoid or maxillary bones was found. A flap to cover the defect was brought down from the forehead."

The laboratory report from Dr. Nuzum is as follows: "The microscopic sections reveal an atypical sarcoma. The bulk of the section is composed of round cells but there are areas of spindle cells. Diagnosis—round-cell sarcoma."

The writer saw the boy May 12, 1920, about two years since the operation. There was then no evidence of recurrence or metastasis.

The terms *melanotic sarcoma* (*melanosarcoma*) and *leucosarcoma* are not particularly accurate or important. The first variety is of much more frequent occurrence, the pigmentation being usually due to

melanin. In hematogenous growths the pigment is derived from the blood.

As for leucosarcomata, many growths appear white until examined microscopically, when parts of the section may appear to be free from pigment while other areas are densely pigmented.

The more important papers on the subject of sarcoma of the eyes, in addition to those already quoted, are as follows:

Avery, J. W. (*Arch. of Oph.*, Vol. 48, p. 287).

Becker (*Archiv f. Ophthalm.*, 1895, 41, 3 Abth., 169).

Enslin (*Klin. M. f. Aug.*, July-Aug., 1904).

Fage (*Arch. d'Ophthalm.*, 1898, Vol. 18, p. 289).

Fleischer (*Ophthalm. Lit.*, ii, p. 142); (papillary lid sarcoma).

Gallemaerts (*Ann. d'Ocul.*, Vol. 156, p. 131).

Guibert (*Recueil. d'Ophthalm.*, 1896, V. 18, p. 527).

Heilfreich (*D. Phys.-Med. Gesellsch. zu Wurzb.*, 1891).

Horner (*Klin. Monatsbl. f. Aug.*, 1871, p. 11).

Igersheimer (*Klin. M. f. Aug.*, Vol. 54, p. 549).

Lafon and Teutieres (*Jour. de Méd. de Bordeaux*, 28, p. 536).

Lotine (*Roussky Vrach.*, July 12, 1903).

Lotin (*Klin. M. f. Aug.*, Mar., 1904).

Montano (*Ann. de Opt.*, Vol. 15, p. 425). (Two cases; one a man aged 26 years, the second, a woman aged 40 years.)

Pereyra (*Arch. di Ottal.*, Vol. 23, p. 281).

Rausohoff (*Klin. Mon. f. Aug.*, 1898, Vol. 36, p. 257).

Rumschewitsch (*Amer. Jour. of Ophthalm.*, 1891, Vol. 8, p. 8).

Sommer (*Die. Oph. Klin.*, No. 52, 1904).

Steiner (*Cent. f. pk. Aug.*, Feb., 1899, p. 43).

Tamanscheff (*Russk. Vrach.*, Vol. 12, p. 504).

Teitz (*Klin. M. f. Aug.*, Vol. 56, p. 130).

Thilliez (*Jour. de Sc. Med. de Lille*, 1898, Vol. 1, p. 198).

Wilmer (*Trans. Amer. Ophth. Soc.*, 1894).

Wood (C. A.) (*Ophthalm. Rec.*, 1898, Vol. 7, p. 128).

Würdemann (*Ophthalm.*, Oct., 1905).

Zimmerman (M. W.) (*Ophthalm. Rev.*, Vol. 12, 1894).

Cylindroma of the eyelid. This neoplasm is, structurally, an *endothelioma*. The perivascular, endothelial tumor cells assume a columnar arrangement and project between translucent cylinders of hyaline connective tissue. The tumor described by Dueros (*Bull. de la Soc. Fr. d'Oph.*, Vol. 30, p. 536) under the name of cylindroma corresponds to the condition called by other writers *tubular cancer*, *mucous chancroid*, *myrosarcoma*, and *alveolar epithelioma*. In ophthalmologic literature it has also been called by Van Duyse *mycogenous endotheli-*

oma. The neoplasm described by Duclos developed for four years along the margin of the lower lid in a man aged 39 years. Recurrence was suspected a year after removal. Histologically, the growth consisted of atypical epithelial masses invaded by bands of connective tissue, most of which had undergone mucoid change. Calderaro (*La Clinica Oculistica*, July, 1908) reports a case of cylindroma of the lids, which recurred and otherwise presented cancerous symptoms. See p. 3659, Vol. V of this *Encyclopaedia*.

Endotheliomata are tumors believed to be derived from the endothelium of the blood and lymph vessels; they are of comparative frequency in the lids. The extent of this group is variably regarded by authorities; some include a large number, while others restrict the class. The complexity of the subject is due in a large measure to the dual tendencies of endothelium; on the one hand showing epithelial tendencies, and on the other hand certain qualities of connective tissue cells. When typical they are comparatively easy to differentiate from other sarcomata or epitheliomata. In other instances, where their endothelial origin cannot be reasonably demonstrated, it is better to avoid the term and use the older classification. See p. 4312, Vol. VI of this *Encyclopaedia*.

Alt (*Amer. Jour. Ophth.*, 23, p. 220) removed a *lymphangioendothelioma* from the lower lid of a woman 60 years of age. A cyst which had existed for years had been removed from the same locality six years previously. Microscopically, there were rows, patches and, in places, rings of epithelium-like cells distributed irregularly throughout a transparent, almost unstained, evidently edematous, connective tissue. The few blood vessels present were almost completely ensheathed by these cells. Kosima (*Nippon Gank. Zasshi*, Sept., 1916) reports a bilateral case.

Perithelioma of the eyelid. Perithelioma is a term that has gained a certain prominence as applied to a somewhat indefinite group of tumors the exact origin of which requires some consideration. There is a fairly well-founded belief that many of the tumors of this group arise from Eberth's perithelial cells, these being distinct from the true adventitial cells. They form an outer boundary between the vessel-wall and the perivascular lymphatics. The tumors have an origin from certain of the vessel-wall cells; the blood-vessels being the structural unit, or center, around which the zones of cells form. While of blood-vessel origin, they in their clinical and gross character, form angioma and endothelioma.

See, also, p. 1410, Vol. II in this *Encyclopaedia*.

Lamb's (*Amer. Acad. Ophth. and Oto-Laryn.*, 1912, p. 3) case of

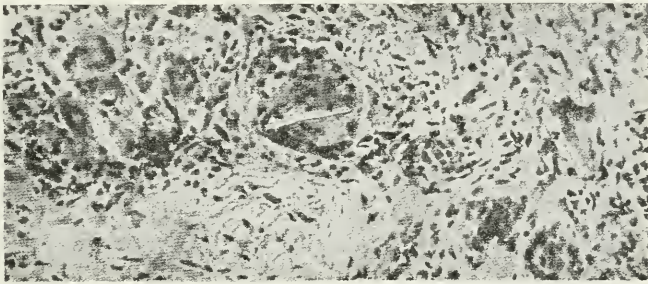
perithelioma was apparently secondary to injury. The patient was a male mulatto aged 50 years. The tumor first appeared on the bulbar conjunctiva and recurred in a form suggesting keloid. The patient subsequently returned with a soft, gelatinous mass on the eyeball, and another on each lid of the affected eye. The tumors were all covered by a sort of gelatinous false membrane, attempts to remove which caused bleeding. Microscopic examination showed a large mass of fibrous tissue containing many blood sinuses, whose walls were surrounded by the cellular proliferation characteristic of perithelioma. An attempt to save the eyeball was unsuccessful, as prompt recurrence made exenteration of the orbit necessary. Bourdier's (*Clin. Ophthal.*, Vol. 19, p. 729) specimens of this neoplasm showed perpendicular implantation of epitheloid-like cells on the vascular walls.

Sarcoid of the eyelid. This term would seem to convey the impression of a tumor formation with the characteristics of sarcoma. Observations since Boeck's publication in 1899, however, have served to complicate the etiological, histological and morphological position of this growth.

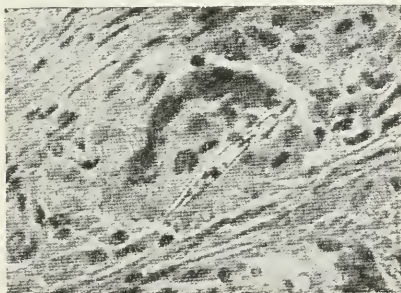
Our purpose in discussing this condition of the eyelid will perhaps be best served by quoting from Derby and Verhoeff's contribution on the subject (*Arch. of Ophth.*, Vol. 46, p. 312). The disease may begin either as a diffuse edematous reddening of the skin which later subsides, leaving one or several circumscribed and infiltrated areas; or it may appear in the form of one or more small nodules sharply circumscribed and situated deep in the skin and raising the epidermis. These nodules may increase in size and coalesce, forming large, flattened, irregularly-outlined patches. The lesions are prone to appear in crops; and may last months or years. They do not caseate, break down or ulcerate. As retrogression sets in, they may become umbilicated in appearance, and finally disappear, leaving pigmented spots or sharply-defined white cicatrices. In color at first red, they later assume a violaceous tint, with marked telangiectases, and then become yellowish-brown. In all forms of the disease miliary foci may be distinguished, situated deeply in the skin and forming the most characteristic feature of the disease. The lesions may vary in number from one to many thousands. They occur by election on the face, back of the shoulders, and extensor surface of the body; and Boeck reports a case, in which the mucous membrane of the nose was involved. Involvement of the lymph glands may or may not take place. The disease usually occurs between the ages of thirteen and forty-five, but has been reported in the earlier and later periods of life. Women seem to be more frequently affected than men.



Sarcoid of the Lid. Showing tubercles at periphery of nodule in skin of eyelid.
Photo x 22. (Derby.)

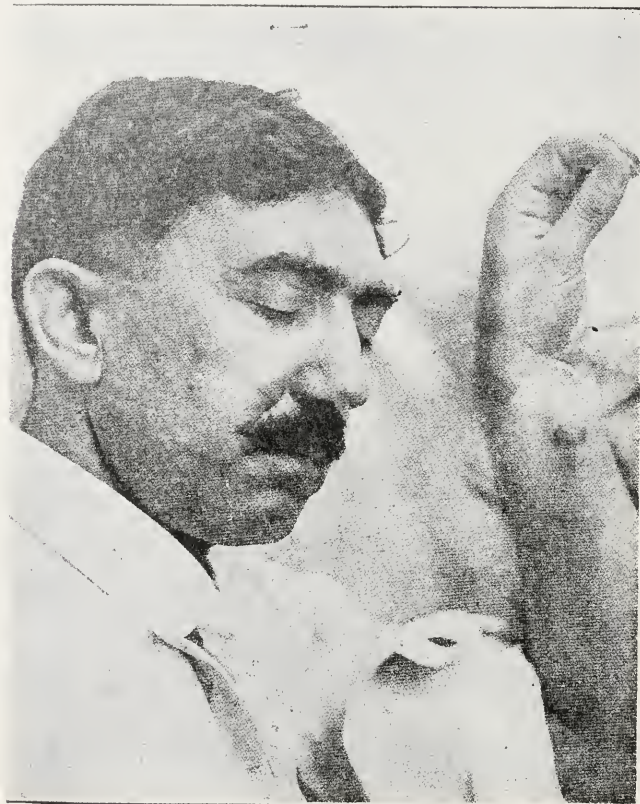


Sarcoid of the Lid. Showing three giant cells each containing a crystal.
Photo x 180. (Derby.)



Sarcoid of the Lid. Giant cell containing a crystal.
Photo x 375. (Derby.)

The *etiology* of the true sarcoid of Boeck is still in the dark. While some writers regard it as a tuberculide, the weight of present opinion is on the other side. While sarcoid has until recently been regarded as a disease of the skin primarily, evidence is beginning to be brought forward to show that the disease, at first, is a general one and that the cutaneous involvement is secondary.



Sarcoid Lesions on Hand and Face. (Zeisler.)

For the diagnosis of sarcoid microscopic examination is indispensable. The clinical appearances are also characteristic, but the following diseases should be taken into account: syphilis, leprosy, *leukemia cutis*, *lupus-erythematosus nodularis*, *erythema induratum* and *lupus pernio*.

The *prognosis* for life is good. The duration of this disease may be weeks, months, or even years; and recurrences are not infrequent.

Regarding *treatment*, Boeck was the first to describe the almost

specific action of arsenic upon these lesions, and other writers have been able to confirm his observations. The X-ray has also been of service, and Darier recommends injection of calomel.

Derby's patient, a female aged 25, is one of the few examples of sarcoïd of the eyelid in the literature. The growth, 3x6 mm., was of about three months' duration. It was flattened, slightly lobulated, hard, almost cartilaginous, yellowish-red and deeply situated in the skin. Removal was followed, three months later, by recurrence. There was no return after the second excision. Verhoeff prepared and examined sections of the mass. There were observed conglomeration of tubercles, partly or wholly separated from each other by connective tissue septa. The involvement extended through the entire thickness of the skin into the underlying fat and muscle. The tubercles were always separated from the surface epithelium by a layer of connective tissue. The tubercles varied greatly in size, and were made up of epithelioid cells which had progressed to an abundant formation of giant cells. They also contained crystals and amorphous precipitate.

Although no precise diagnosis was made at the time, later, S. B. Wolbach suggested that the condition was that described by Boeck. Twenty-five references to the literature on this subject accompany the report.

Zeisler (*Jour. A. M. A.*, 1915, p. 65) has also reported a case of sarcoïd, a picture of which is given in this text.

Verruca, *Wart*, *Papilloma*, *Verruca plana juvenilis* and *Verruca senilis* are types which occur on the lids and lid margins. The common wart is a hard, papillary growth usually with wrinkled or cracked surface, showing a protuberance of proliferating epithelium, with a hyperplasia of the sub-epithelial fibrous and vascular tissues.

Verruca plana is usually a flat, yellowish-brown elevation observed in the young. *Verruca senilis* is frequently multiple, yellowish-brown and covered with scales. The epithelium is generally thickened, with moderate increase in the horny layers and often showing pigmented down-growths of plugs of epithelium. This type is important owing to the possibility of its giving rise to carcinoma. See, also, p. 5029, Vol. VII.

According to Collins and Mayou, the relative amount of fibrous tissue, blood vessels and overlying epithelium varies in different growths, and for purposes of classification they are called fibromata—fibroangiomatica or papillomata according to which element preponderates. Often growths are met with presenting the appearance of a papilloma in one part and of a fibroma or fibroangioma in another.

Freytag (Graefe's *Arch. f. Ophth.*, Vol. 90, p. 367) reports the clinical history and histological examination of a case of benign, multiple papilloma of the upper and lower lids (left eye) of a child, aged 4 years, without known etiology, which relapsed several times after excision. A review of the literature showed that papilloma was observed on the ocular conjunctiva in 6 cases, limbus 11, semilunar fold and caruncle 10, conjunctiva of the upper lid 3, lachrymal sac 1. Although papilloma generally is a benign tumor, occasionally a transition into carcinoma occurs, as shown in 4 cases. The *treatment* of this growth consists in excision into the surrounding healthy tissues. Papilloma has a tendency to relapses, an observation made in 12 out of 34 cases.

Birch-Hirschfeld (*Zeitschrift. für Aug.*, 34, p. 291) observed a contact papilloma at the intermarginal border of the lower lid exactly where it touched the apex of the limbus growth. It was the size of a small bean and had the form and aspect of an acuminate condyloma. There was no recurrence following excision.

Xanthelasma of the eyelids. *Xanthoma palpebrarum* appears as a small sulphur-yellow plate or patch (*planum*) or rarely as nodules (*tubercular*). The former occurs in oval or crescentic plates varying considerably in size, even with or slightly raised above the surface of the skin, and at times becoming confluent. They are more frequently observed in the neighborhood of the inner angle and may involve both eyes. They usually occur in patients past middle life; are more common in females; occur in families, and many patients give a history of attacks of jaundice or migraine. See p. 5030, Vol. VII of this *Encyclopedia*.

Parsons (*Pathology of the Eye*, Vol. 1, p. 9) gives the following description of the microscopic changes: "They are chiefly in the middle and lower layers of the corium, and consist of aggregations of large epitheloid, multinucleated, oval, round, or polygonal, finely granular cells, lying in a fine meshwork of connective tissue, and separated from one another by bands of connective tissue. The cells form irregular masses, or whorls and nests, this arrangement being due to their formation around a blood-vessel. Yellowish-brown pigment is scattered about within and amongst the cells, also in the cells of the *rete Malpighii*, a large number of which are vacuolated. The xanthoma cells undergo fatty degeneration and seem to run together so that their contour is indistinct. They may at first be spindle-shaped, but later are pressed together like epithelial cells."

Regarding the presence of fat in these growths it is rather an infiltration than a degeneration. Long, needle-like crystals are obtained from glycerin preparation of the tissue. The nuclei take a stain well.

The condition, although described under the heading of tumors, is really a degenerative process in the skin. The disfiguring effect is the only objectional feature. *Treatment* is not very satisfactory, excision, electrolysis and roentgen-ray may be tried. [An application—usually only one is necessary—of a 1 per cent. solution of mercuric chloride in collodium is generally followed in 10 days by the fall of a dried exudate, a smooth superficial scar—and cure.—*Ed.*]

Mawas (*Ann. d'Ocul.*, Vol. 151, p. 437) in discussing the histology and histochemistry of xanthelasma concludes that the essence of xanthelasma cells consists in the formation in the protoplasm of a lipid substance in the form of minute drops, which gradually occupy the entire cell. This substance differs in its reaction from ordinary fat. The degenerated cells unite, so that, like giant cells, they show several nuclei.

Birch-Hirschfeld (*Graefe's Arch. f. Ophth.*, 57, 2, 207) discusses the anatomy of xanthelasma of the lids. Morax (*Rec. d'Ophth.*, Oct., 1906, p. 615), observed a patient with multiple patches affecting all of the lids, and with spots on the face and scalp.

Villard and Bose (*Arch. d'Ophth.*, June, 1903) claim permanent and complete removal of this condition by electrolysis. Two needles are inserted in opposite borders to a length of not more than 10 mm. The current is then gradually turned on to a maximum of 8 milliamperes. After two to four minutes the current is gradually turned off. For smaller growths one needle may be used, the moistened anode plate being held in the patient's hand.

Xeroderma pigmentosum. Melanosis lenticularis. Kaposi's disease. This is, comparatively, a rare disease of the eyelids. It is first observed, in congenitally predisposed subjects, on those parts of the body most exposed to light, such as the hands and face. It occurs chiefly in juveniles between the fifth and the tenth years; or in old age. It may affect several boys in a family, the girls being usually unaffected.

It is marked by an overgrowth of pigment epithelium, scaling, ulceration and atrophy of the affected skin, the last being followed by a warty growth subject to malignancy. The early clinical appearance is of a small, brownish or black freckle, slightly elevated; later telangiectases and atrophy of the skin, followed by the warty elevation. These lesions are subject to secondary changes, such as angioma, myoma, pigmented sarcoma and, especially, epithelioma. Darier observed multiple carcinoma following xeroderma pigmentosum which resulted from the excessive use of arsenic. The *etiology* is unknown; *prognosis* unfavorable and *treatment* of little service. Excision, cauterization or desiccation may be tried.

See, also, **Kaposi's disease**, p. 6740, Vol. IX of this *Encyclopedia*.

Brand (*Zeit. für Aug.*, Vol. 24, p. 524) saw xeroderma pigmentosum associated with epithelioma of the upper lid in a child that was feeble-minded and parietic, and who presented syphilitic stigmata. The skin of the face, arms and legs was dark-brown. On the cheeks were bright, white flecks of beginning xeroderma. The growth in the lid appeared as a neglected chalazion, but in section was like cartilage. Histologically it was epitheliomatous with foci of pigment. Cross (*Tr. Ophth. Soc. V. K.*, Vol. 32, p. 55) observed Kaposi's disease in a brother and sister. The parents (cousins) were healthy.

Dean (*Ophth.*, Vol. 11, p. 670) and Kessler (*Jour. A. M. A.*, Vol. 65, p. 300) report in full detail two cases of this affection in two children, a sister and brother. The ocular lesions consisted in both cases of ectropion of both lids of each eye, due to the formation of a warty-like mass on the eye lids having the appearance of epithelioma. The anatomical diagnosis was squamous cell carcinoma of the eye lids. Kessler administered autogenous serum with benefit. He thought that if given early it might have been of even greater value. Dean included a case in a woman, aged 28 years, observed by Jackson.

Cuperus (*Tydschr. V. Gen.*, Jan. 26, 1907) discusses a case, a girl aged 10 years, who began to show evidence of *xeroderma pigmentosum* at the age of 3 or 4 years. At the time of observation there was present carcinoma of the right upper lid in connection with the original disease.

Velhagen (*Arch. of Ophth.*, Vol. 37, No. 2, p. 182) contributes very fully to the literature of this subject. The family histories, in the case-reports cited, are of particular interest. Three brothers, X, marry three sisters, Y. Among the children of two of these couples five cases of xeroderma are found; not a single one among the offspring of the third union. As another X married outside of the Y family, and three Y sisters married men who were not related to the X's without xeroderma appearing among their children, we cannot decide whether the germ of the disease is in the X family or in the Y's.

The history of the first two cases reported, who were greatly exposed to sunlight, speaks very strongly in favor of the sunlight theory as an etiological factor.

TUMORS OF THE CARUNCLE AND PLICA SEMILUNARIS.

By the confluence of the nasal ends of the upper and lower lids the internal canthus is formed, which surrounds a horse-shoe-shaped depression. Stretching across this area is a vertical fold of conjunctiva, the *plica semilunaris*, which is the rudiment of a third lid. In many

birds and other animals this fold is prominently developed. In the depressed area of the nasal side, internal to the plica, is a reddish-grey elevation, the *caruncula lacrimalis*, a small island covered by modified skin containing glandular depressions, fine, light-colored hairs, sebaceous glands and, according to Fuchs, sweat glands. At the apex there are many layers of pavement epithelium which gradually change until at the base they assume typical conjunctival epithelium.

While both cutaneous and conjunctival tissue enters into this complicated structure, offering all the morphological and etiological elements for neoplastic growth, tumors of this region are relatively rare. The *benign* growths of the caruncle are *adenoma*, *angioma*, *dermoid*, *fibroma*, *lymphoma*, *navus* and *papilloma*; the *malignant* forms are *sarcoma* and *carcinoma*. See pp. 1406 and 1432, Vol. II of this *Encyclopedia*.

During the past seventeen years about thirty contributions have been made to the literature of the subject, recording about fifty cases. Papillomata (eleven reports) were the most frequently observed.

Beauvieux (*Arch. d'Ophth.*, Vol. 33, p. 216) has classified tumors of the lachrymal caruncle, and has adopted in the main the classification used by Lagrange. He divides these tumors into three main groups, epithelial, conjunctival, and mixed. The first group includes as *benign* tumors, adenomata, simple cysts, papillomata, papillomatous polyps, and granulomata; as *malignant*, epitheliomata and carcinomata. The second group: *benign*, fibromata, hyaline tumors, angiomata, lymph-angiomata, lymphomata; *malignant*, sarcomata, lympho-sarcomata, and melanosarcomata. The third group are all *benign*; simple hypertrophy, papillary-lymphangiectatic-fibroma, fibromata, dermoid cysts. His first case was one of typical papilloma in a woman aged 40 years. The second case was a lymphoma in a man aged 68 years, affecting the caruncle on both sides. This case is claimed as unique, Beauvieux having failed to find a record of a similar one. The third case was a man aged 28 years, with a papillary-telangiectatic-fibroma.

Watzold (*Cent. f. p. Aug.*, Vol. 37, p. 42) states that among 60,000 patients he has seen only six instances of neoplasm of the caruncle, all of which were in patients between the ages of five and twenty years. Three were congenital, two being nevus and one a dermoid; three others, a papilloma, a fibroma, and a fibro-adenoma, were not present at birth.

Adenomata of the caruncle are similar in character to the same type of growths described in connection with the sudariparous, sebaceous and Moll's glands of the lid. They are firm, pinkish, pedunculated or sessile growths; occasionally cystic. They occur in connection with

the acino-tubular glands, or form vestigial glands of the plica. Sections show tubules and dilated spaces, or cysts lined by a single layer of cylindrical epithelium, the contents being degenerated cells and débris. Between the spaces is loose fibrous or connective tissue. They are of slow growth, attaining at times considerable size, and invading surrounding structures. Removal should be thorough and complete.

Prudden (*Arch. of Ophth.*, Vol. 15, p. 1, 1886) has described adenoma of the caruncle as consisting of a collection of tubular, branching structures having large and small, mostly central lumina, which resemble tubular follicles, and are lined with cuboidal and cylindrical epithelium. The author's patient was a woman aged 74 years. The growth was of seven years' duration, but attended with no pain or inconvenience. It was a soft, reddish, globular tumor, measuring 4 mm. by 5 mm.

Coats (*Royal Lond. Ophth. Hosp. Reports*, Vol. 18, pt. 3) studied an adenoma of the sweat glands of the caruncle (*spiradenoma papilliferum cysticum*) obtained from a patient aged 77 years. The growth had been noticed for eighteen months. It was oval, measured 8 by 5 mm., and is described as a cyst with free, papillomatous proliferation of the wall. From its inner surface there arises a system of delicate fibrous strands, bearing fine blood vessels, branched and folded in the most complex manner. See the figures. Each strand is clothed with an epithelium which is much thicker than the strand itself, and which has the two-layered arrangement characteristic of sweat-gland tumors; but both layers show slight divergences from the normal. The papillomatous proliferations encroach on an irregular central cavity, which is filled with débris, desquamated cells and a few blood corpuscles. Among the epithelial strands numerous small lumina are found, containing similar débris.

That the tumor originated in a sweat-gland is proved, the author-investigator believes, by the character of the epithelium; that it originated in the body of the gland, not in the duct, is shown by the dissimilarity of the two layers; since it consists essentially of a single cyst, though subdivided by the papillomatous proliferations, it seems evident that it was formed from a single tubule. The only other glands in the vicinity from which a tumor with approximately the same structure could arise are the glands of Krause, the ducts of which also have a double epithelium; in these glands, however, the cells of both layers are flat or cubical, and similar, and the cases of adenoma of the glands of Krause which have been reported by Salzmann, Rumschewitsch, and others, have no resemblance to the present observation. That sweat-glands do occur in the caruncle is now generally admitted; ac-



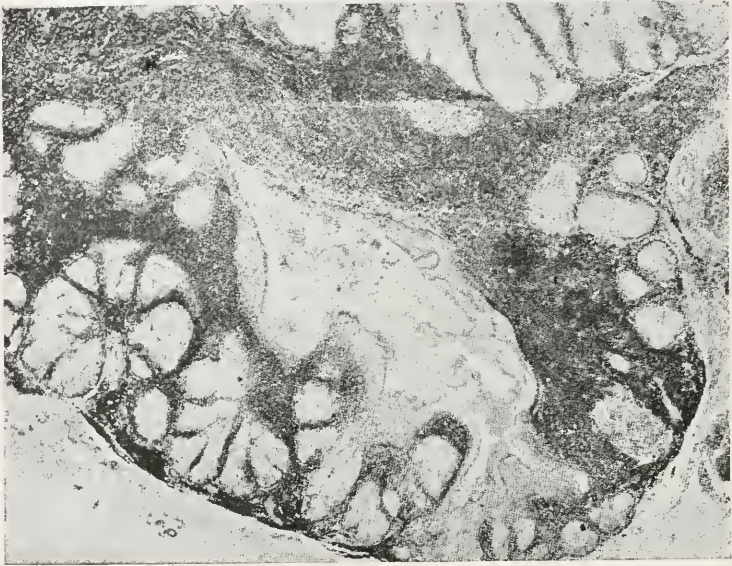
Spiradenoma Papilliferum Cysticum. The papillomatous proliferations projecting into the cyst cavity. Smaller spaces are enclosed among them. The external fibrous wall has become torn off in this section. (Coats.)



Spiradenoma. $\times 120$. Higher power view of same case to show structure. The epithelium rests upon a fine central strand of fibrous tissue. It consists of an inner layer of very high cylindrical cells, with their nuclei near their inner surface. Among their feet an interrupted layer of smaller nuclei is visible. Homogeneous and granular coagula are present among the strands. (Coats.)

according to Virchow they are modified in the same way as the glands of Moll.

Coats (*Roy. London Ophth. Hosp. Reports*, Vol. 18, pt. 3) also obtained from a woman aged 68 years a flattened papillomatous growth measuring 10 by 12 mm., which was attached by a broad pedicle to the caruncle. The growth proved to be an *adenoma of the sebaceous glands of the caruncle*. The deeper portion of the tumor consists of a mass of hypertrophied and new-formed sebaceous glands (see the



Sebaceous Adenoma of the Caruncle.

× 34. Glandular masses showing typical sebaceous structure surround a central cavity filled with debris. There is much lymphocytic infiltration among the acini. (Coats.)

figure). Connective tissue septa divide the growth into lobules, separate the individual glandular masses, and cause small invaginations in the walls of the gland acini. The delimitation from the surrounding tissues is perfectly sharp, but there is no well-defined capsule.

The normal structure of sebaceous glands is perfectly imitated. In the periphery of the acini the cells are small, dark and relatively flat; in the center they are large-bodied, have a pale nucleus, and show in their protoplasm the reticular appearance of cells from which fat has been dissolved. Sometimes the acini are entirely filled with desquamating cells, debris, and leucocytes. The adenomatous tissue comes close up to the surface epithelium. The condition here is not a hypertrophy

of isolated glands, but a localized tumor, forming the greater part of the whole growth, and composed entirely of glandular acini. It seems certain, therefore, that some of these acini must be new-formed, and that the growth is therefore entitled to a place among the true neoplasms.

Testelin's (*Dictionnaire Encyclopédique des Sciences Méd.*) patient was a girl aged 18 years. The adenoma, which likely was from the sebaceous gland, was a flattened, lobulated, firm, yellowish mass about the size of a large pea. Sections showed it to be exclusively formed of a glandular structure similar to the normal glands of the caruncle, but in much larger numbers.

Schreiber's (Graefe's *Arch. f. Ophth.*, Vol. 84, p. 420) case of tumor of the caruncle proved to be a benign adenoma, derived from a sebaceous gland. The patient was a man aged 58 years, and the tumor had been first noticed at the age of 12 years.

Veasey (*Ann. of Ophth.*, Vol. 11, p. 386) observed a bluish-red, pin-head-sized spot beneath the surface of the caruncular tissue. The removed growth, upon section, measured 1.4 by 1 mm. The nodule was composed of convoluted masses of tubular gland acini, each of which possessed a distinct basement membrane, lined with tall, narrow, columnar, epithelial cells. Many of the acini had a narrow lumen, but most of them were widely dilated and showed a tendency to cyst formation. The nodule had no distinct capsule, although the surrounding connective tissue had been so condensed by its growth as to suggest such a structure. A diagnosis of *cystic adenoma* was made.

Von Graefe's (*Arch. für Ophth.*, Vol. 1, p. 290) patient was a boy aged 10 years. The growth attained the size of a hazel-nut. There were fine hairs on the surface and numerous small openings which were obviously of a glandular nature.

Steiner (*Cent. f. p. Aug.*, June, 1910) reports an instance of adenoma of the caruncle in a Javanese. The mass extended over the corneal margin. The surface of the growth was irregular and granular, its color stippled red and white. Schirmer (Graefe's *Arch.*, Vol. 37, 1891) reports four personal cases. Fontan (*Recueil d'Ophthal.*, 1881, p. 35) also gives a case.

Carcinomata of the caruncle are most frequently observed in the conjunctiva near the limbus and occasionally in the neighborhood of the caruncle. While of relatively rare occurrence it is quite possible that many apparently innocent caruncular growths if carefully examined might prove to be malignant rather than benign. The rarity of this neoplasm, furthermore, is rather singular in view of the fact that caruncular conditions seem favorable to tumors owing to the

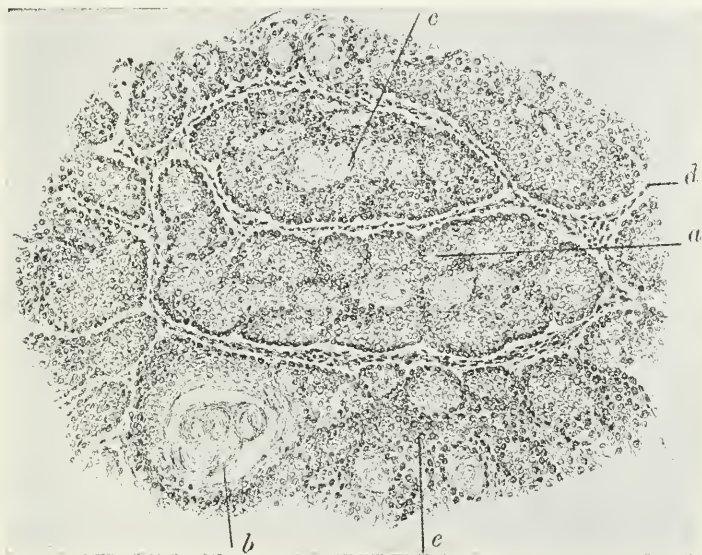
state of the tissues—one variety of epithelium (modified skin) passing into another, conjunctiva (Lagrange).

The tumor varies in size from a very small nodule to a papillary growth of considerable size protruding between the lids at the inner angle. It is yellowish-brown, bleeds easily and, later, may ulcerate. Single, small nodules may be present in adjacent parts. The neoplasm may invade adjoining structures, and recurrence after removal usually takes place. Histologically, the growth has the same characteristics as cancer observed in other parts. The epithelium shows down-growths that divide and anastomose, forming a net-work. In the neighborhood of the basement membrane it is difficult to determine whether it partakes of epidermal or mesodermal origin, since the cells shade off into each other. *Treatment* is excision, cauterization and desiccation, the last-named being probably the most satisfactory.

de Schweinitz (*Trans. Amer. Ophth. Soc.*, 1898) studied a *primary carcinoma of the caruncle* in a man aged 52 years. The growth, about the size of an ordinary pea, sprang directly from the right caruncle, which it practically replaced, and terminated in a slightly pediculated attachment. It was of reddish-yellow color and had existed for a number of years. In recent times it had grown slightly and caused some irritation; therefore its removal was desirable.

Sections presented the following characteristics: Externally there was a covering of flattened epithelial cells directly succeeded by long tubules, or plugs of spheroidal epithelial cells agglutinated together, but not held in a capsule. Between these plugs there was a delicate stroma composed of fine spindle-cells and collections of small round cells. In some places the spindles were drawn out into fibers, giving the impression of the beginning of a delicate connective tissue. In many of the plugs, near their centers, were areas of degeneration which in their later stages closely resembled “concentric globules,” “bird’s nest bodies,” or “pearly bodies,” as they have been variously called. (See the figure.) That these areas represented collections of dead epithelial cells, which had arisen probably because of the mutual pressure of the cells one against the other, was readily demonstrable in those spots where the earliest stage of the process could be studied, and where the cells could be seen in all stages of degeneration, from those that were just beginning to lose their power to accept the staining reagent to those which were completely necrotic and pushed aside and packed together in the concentric lamina forming the globule. There were no blood vessels to be seen among the cell groups. Except

perhaps for the epithelial covering, there was not a trace of the original caruncular structure. It had literally been replaced by tumor formation. In some respects this growth resembled an adenoma of the caruncle, but there are evident important differences and the arrangement of the cells as seen in this growth is analogous to the cancer plug in many of the epitheliomata. See, also, **Carcinoma of the caruncle**, p. 1406, Vol. II of this *Encyclopedia*.



Primary Carcinoma (Epithelioma) of the Caruncle.

(Zeiss' Ocular 4, obj. 16 mm.)

a, Plug of epithelial cells; b, c, Concentric globules; d, Stroma, composed of spindle and round cells; e, Small round cells, "indifferent tissue."
(de Schweinitz.)

A. Menacho (*Archivos de Oftalmologia*, Aug., 1915) studied a primary *pavement epithelioma of the lachrymal caruncle*. The patient was a man aged 55 years. He stated that the left caruncle (which had always been larger than that of the other side) had, in the past two months, taken on a rapid and progressive growth, being at the time of examination eight millimeters in diameter. It was yellowish in color, and its clinical aspect was that of a papilloma without hairs, but with sebaceous hyperplasia. Under the microscope it showed an epithelial structure, with a connective tissue stroma. It contained a number of young epithelial "perles," very few of these being completely kerati-

nized. The author suggests that if microscopic examination were made in a greater number of cases of supposed papilloma of the caruncle, the occurrence of epithelioma (primary in this structure) might be found to be less rare than is commonly believed.

Aurand (*Revue Générale d'Opht.*, Mar. 31, 1908) removed from the left caruncle of his patient a small, black tumor, 2 by 3 mm. A recurrence was not noted. His patient had several pigmented moles on his face and lids. Under low magnification the corneum and deeper tissues showed an infiltration with irregularly disseminated melanotic cells; in places these formed a distinct stratum in contact with the deeper Malpighian layer. In one place they appeared as a well-limited, oval, blackish mass surrounded by a thin fibrous capsule divided by strands of tissue. In its center were blood vessels and hairs whose sheaths appeared to be invaded by melanotic cells. Sections revealed cells disseminated without definite order; in places they appeared as plaques, nests or as large deeply-pigmented cells, polyhedral in outline, with an invisible nucleus, resembling epithelial cells. Some cells were smaller, with less pigment and a visible nucleus. An actual invasion of the hair-sheaths and glands by the cells was not demonstrable, although such a tendency was apparent. Consequently the point of origin of the tumor was not in these structures but very probably in the deep layers of the Malpighian epithelium. Diagnosis; *melanotic epithelioma* arising from the Malpighian cells; a tumor which until recently was designated *alveolar melanotic sarcoma*. The absence of a definite arrangement of cells and an absence of intercellular fibrous stroma (conditions common in carcinoma) and the presence of alveolar structure seem to question the correctness of the diagnosis.

Despagment (*Rec. d'Opht.*, Jan., 1888) describes a melanotic new-growth of the caruncle under the term of *epitheliome melanique*. It had attained the size of a pea and was adherent to the caruncle by a pedicle. Pathological examination showed that this growth developed from three distinct sources, the surface epithelium of the caruncle, the epithelium of the sebaceous glands and from that of the hair follicles. Mantey, Blum and Saemisch dispute the authenticity of this classification and believe it to be a melanosarcoma; Aurand accepts it as an epithelioma.

Petit's (*Ann. d'Ocul.*, July, 1906) case, a woman aged 82 years, presented a tumor of the caruncle about the size of a pea, with an irregular surface and not pedunculated. This was removed with scissors; after two years there was no recurrence. Under low magnification the surface epithelium appeared greatly thickened and took a deeper stain. In its depth were seen rounded "globules," resembling pearls. The epithelium was arranged in concentric layers, not unlike an onion

bulb. The underlying connective tissue projected into the epithelial layer as long, filiform papillæ; in some places these were quite regular, suggesting a benign tumor, a papilloma. In other localities the epithelium penetrated into the underlying tissue as irregular masses within which were the epithelial "pearls." Under high magnification the epithelium appeared flat and stratified; all cells appeared living and stained well. Cornification or karyokinesis was not noted. The connective tissue was infiltrated with embryonic masses. *Diagnosis:* Flat-celled epithelioma with formations analogous to epithelial pearls.

Mantey (*Inaug. Diss. Greifswald*, 1896) described a tumor of the caruncle in a male aged 65. For three weeks he had noticed a small growth at the inner canthus of his eye, which had enlarged rapidly in size. When first seen by Mantey it measured 6 by 14 mm., and projected from between the lids. It involved the plica semilunaris and had



Bilateral Carcinoma of Caruncle. (Dernehl.)

a small bridge of attachment with the conjunctiva of the bulb, but was free from the conjunctiva of the lids. Microscopically, it proved to be a carcinoma rich in cells. The cells were lodged in a delicate reticulum and involved the tissue as coiled strands. Their nuclei were large, with distinct nucleoli. In type the growth was distinctly epithelial, and bore a strong resemblance to a gland carcinoma, on the strength of which Mantey believes it to have arisen from Krause's or from the sebaceous glands. Three months after removal there was no recurrence.

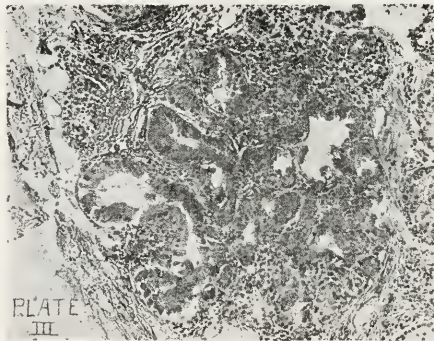
Dernehl (*Ophthalmology*, Vol. 12, p. 58) discusses very fully the subject of *primary carcinoma of the caruncle*. He reports the unique experience of having observed bilateral growths in a man aged 56 years. The right caruncle was practically replaced by the growth, which measured 6 by 7 mm. It was firm to the touch, brownish-red and did not appear to be very vascular. The left tumor appeared as a small, surfaced knob. Sections of the excised growth showed solidly filled alveoli. The cells were relatively small, with spindle-cells pre-

dominating. They were closely packed and here and there in the large alveoli was found a tendency to cell nest-formation. A diagnosis of *basal-celled epithelioma* is given with the comment that this type of tumor is often multiple, does not metastasize, but has a tendency to invade.



Carcinoma of Caruncle. Low Magnification. (Dernehl.)

Seitz (*Handbuch d. gesamten Aug.*) in 1855 reported a case in a male aged 51 years. The tumor, at first barely noticeable as a blackish-red spot, increased rapidly in size without causing discomfort or pain. When first seen it had attained the size of a bean, was somewhat



Carcinoma of Caruncle. High magnification. (Dernehl.)

lobulated and had extended from the inner canthus to the corneal margin. It was adherent to the underlying conjunctiva and the nasal portion of the upper lid. Following its thorough removal there were three recurrences within eight months. The first showed as a pin-head-sized spot upon the inner surface of the lower lid; the second as a bean-sized tumor between the upper lid and the globe and the third as a

somewhat smaller growth upon the same site. Microscopically, it was shown to be a large, round-celled, pigmented carcinoma.

Sgrosso (*Ann. d'Ottal.*, 18, 1889) removed a *melanotic carcinoma* from the caruncle of a woman aged 79 years. It had attained the size of a pea after three years' standing. Danis (*Bull. de la soc. Belge. d'Ophth.*, Vol. 28, p. 22) and Sherwell (*Jour. Cutan. Dis.*, Vol. 28, p. 292) have both reported similar neoplasms of the caruncle.

Cysts of the caruncle possess characteristics similar to those observed in the conjunctiva and other structures of the ocular apparatus. They are frequently classified as *traumatic*, *parasitic*, *lymphatic*, *congenital* and *retention* cysts. The traumatic cyst results from the implantation of epithelium. Lymphatic cysts bear a close pathological relationship to lymphangioma and lymphangiectasis. The congenital cyst is represented by the dermoid. Retention cysts develop in the duct or in new-formed glands.

Cysts form small, blister-like elevations, that have a tendency to increase in size. They result from inflammatory processes, are multilocular and contain fatty epithelial debris, clear or slightly turbid fluid. They should be incised and the limiting capsule destroyed.

Two cases of cysts, arising from degenerative changes, in the region of the caruncle are reported by Rumschewitsch (*Klin. M. für Aug.*, July, 1903). Both were removed and studied microscopically. The first case was one of chronic trachoma, in the stage of cicatricial contraction. The cyst in the larger (vertical) diameter measured 10 mm. It was believed to have arisen by degenerative changes in a gland; or the glands were infected by trachoma. The second patient, when seen two years previously, had been suffering from hyaline degeneration of the conjunctiva. The cyst in this case had a long diameter (vertical) of 15 mm. A mucoid degeneration seemed to have occurred in an obstructed gland, or glands. The removal of these cysts was followed by no complication or recurrence.

Steiner (*Cent. f. p. Aug.*, June, 1910) observed, in a woman aged 72 years, a small, yellowish, sharply-defined, movable growth situated in the upper layers of the caruncle. Microscopic examination showed it to be a cyst springing from the sebaceous glands of the caruncle, similar to those met with in the skin.

Dermoids of the caruncle. The occurrence of these tumors is in dispute. See, also, **Dermoids**. Quite a few have been reported, but mostly in the plica. Bock (*Klin. M. für Aug.*, Vol. 24, 1886) described a tumor consisting of dense fibrous tissue, unstriped muscle, sebaceous glands, medullated nerves and a few hairs. The author points out the possibility of the growth being a hyperplasia or fibro-lipoma of the caruncle.

Epithelioma, which is rare, has been discussed under carcinoma of the caruncle.

Fibromata of the caruncle appear as reddish-gray, smooth, usually pedicled or polypoid growths. They are hard or soft according to the amount of fibrous tissue present. The hard growths contain a large amount of fibrous tissue and few blood vessels. The soft tumors possess less fibrous tissue, which is edematous, but a large amount of vascular tissue. They bleed easily, and are more liable to recurrence than the hard variety. They usually appear on the plica. Excision, cauterization, or desiccation is the proper method of treatment.

Watzold (*Cent. F. p. Aug.*, Vol. 37, p. 42) and Beauvieux (*Arch. d'Ophth.*, Vol. 33, p. 216) also describe instances of this neoplasm.

Hyaline, colloid and amyloid tumors of the caruncle are flat, reddish-yellow masses of degeneration. They vary greatly in their chemical constitution, and are probably formed by exudates or secretions.

Schreiber (Graefe's *Arch. für Ophth.*, Vol. 84, p. 420) reports a case, apparently unique in the literature, of hyalin tumor of the plica semilunaris. It was a flat growth, the surface of which was mottled red and yellow. It had been present for fourteen years. Microscopically, it was characterized by the presence of widely distributed, homogeneous, flaky, glassy masses of decidedly infiltrative character.

Lymphomata may affect the plica semilunaris. In appearance they are similar to enlarged follicles. They produce no inconvenience; are usually small, but on occasion attain considerable size. They have been known to develop a malignancy of the character of a lymphosarcoma. They exhibit the structural characteristics of a lymphatic gland, with a stroma of fine fibers, endothelial cells, and small blood vessels.

Coats (*Arch. of Oph.*, Vol. 44, p. 235) reports a patient with a *lymphoma of the plica semilunaris* consisting of a single, gigantic lymph follicle. Simple lymphoma has been observed in young people, but always at the inner portion of the conjunctiva. It apparently never reaches any considerable size.

Van Duyse (*Bull. de la Soc. Belge d'Ophth.*, No. 29, p. 27) reports an instance of lymphoma of the plica semilunaris. Beauvieux (*Arch. d'Ophth.*, Vol. 33, p. 216) reports a lymphoma in a man aged 68 years. The case was unique in that both caruncles were affected in the same way.

Lymphangioma, a tumor consisting of cavernous or capillary lymph spaces lined with endothelium, rarely affects the caruncle and plica semilunaris; lymphangiectasis is of much greater frequency.

Nævus of the caruncle is of infrequent occurrence. In structure it

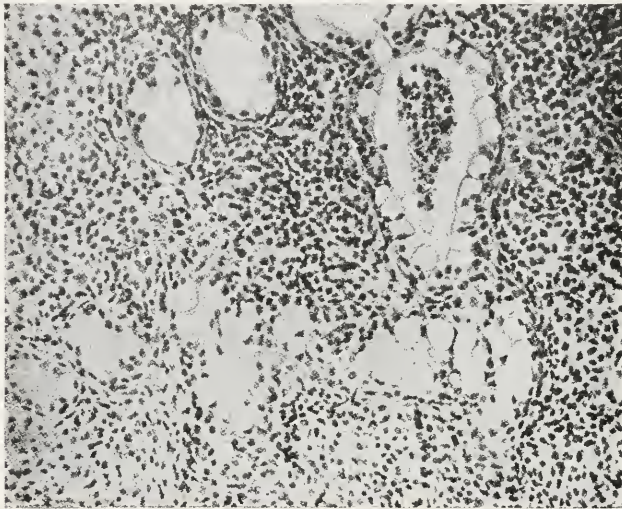
is similar to that found in the conjunctiva. It is congenital, or at least the rudimentary histological elements exist at birth. The tumors are pigmented and non-pigmented; the former is observed more frequently, and in older people. They are soft, smooth, yellowish-red elevations, presenting much the appearance of hypertrophy of the caruncle. Microscopic sections show long, epithelial processes extending into the stroma. While usually considered benign and at times quiescent, yet the histological characteristics, the tendency to renewed activity and their exposed position all foster malignancy. They should be thoroughly removed or destroyed.

Alt (*Amer. Jour. Ophth.*, Vol. 34, p. 1) studied a soft, pinkish growth about the size of a pea which proceeded from the left caruncle. It presented the microscopic appearance of hypertrophy of the caruncle. It was observed in a woman, aged 35 years, who stated that it had been present for 25 years, had never been painful, but in cool weather crusts formed, the removal of which caused bleeding. The little tumor was found to consist of an anterior solid cellular part and a posterior less compact segment. The anterior, more solid part was not in direct contact with epithelial covering. Everywhere a varying quantity of less compact connective tissue intervened between it and the epithelium. This intervening tissue contained a considerable quantity of pigment. Under a higher power the epithelial cover was seen to be of varying thickness; the tissue lying just underneath it was a connective tissue poor in cells. Many of these contained a granular, yellowish-brown pigment. The color varied, sometimes being so dark that it was almost impossible to see their nucleus while in other areas the pigmentation was considerably lighter. There were, also, smaller and larger masses of pigment granules which were apparently free in the tissue. This pigmentation was irregularly distributed and also reached in some places farther into the depth of the tissues. While the tissue intervening between the epithelium and the naevus cells contained numerous small blood vessels there were but few to be found in the real naevus tissue. Of the numerous sebaceous glands present in the normal caruncle, parts only, and no excretory ducts, were found.

"The portions still existing are all transformed into small cystic cavities lined with one or two layers of epithelial cells which are undergoing a regressive metamorphosis. These cells are most of them transformed into spherical bodies containing a more or less clear material, probably a mucoid degeneration. That this destruction of the glandular tissue is due directly to the pressure and the cutting off of their nutrition by the naevus cells, seems apparent. However, it is not

the outside pressure alone, since in numerous gland remnants the nævus cells have evidently invaded the glands and grown within them (see the figure), so that the glandular structures had to yield to the pressure of the nævus cells from without and within. Even the small sebaceous glands belonging to the few fine hairs have undergone or are undergoing this process of regressive metamorphosis."

Whether the cysts that have been described by others as nævi are explained by this mode of destruction of the glandular tissue, is not quite clear, but seems very probable. In this nævus the cells do not seem to have been derived from the epithelium, as in no section (and



Histological Appearance of the Nævus. (Alt.)

the whole tumor was sectioned) are the nævus cells in contact with the outer epithelium. The arrangement in this tumor gives the impression that the nævus cells have grown from the deeper connective tissue parts towards the epithelium. Very few of the nævus cells proper contain pigment; the larger amount of chromatophores lies in this small layer of connective tissue.

While the nævi of the conjunctiva Alt (*Amer. Jour. of Ophth.*, Oct., 1916) has previously described seemed decidedly to speak for Unna's opinion that the cells are derived from the outer epithelium, the specimen here described seems rather to support Ribbert's view, that the nævus cells are of connective tissue origin.

Bergmeister's (*Zeit. für Aug.*, Vol. 25, p. 495) specimen showed in places cell bridges between the epithelium and the cluster of nævus

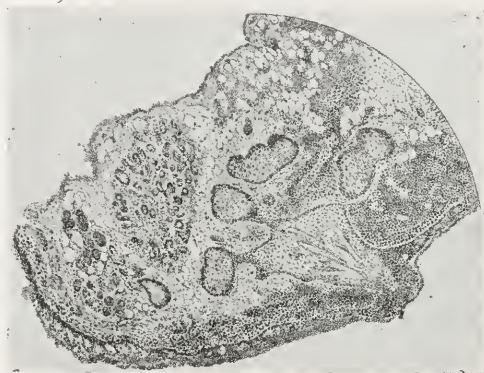
cells. Where groups of naevus cells were in contact with the epithelium the basal cells were lacking and in their stead was homogeneous tissue containing small spaces and isolated nuclei.

Anselmi (*Arch. de Ott.*, Vol. 19, p. 611) reported a case in a girl aged 17 years. The mole had been noticed since early childhood. From microscopic examination of the excised caruncle and naevus, the author is satisfied that the naevus cells were derived from epithelium. The migration of the epithelial cells into connective tissue of the caruncle is attributed to a power of slow locomotion on the part of the young cells. The power which fixed connective tissue cells have to form collagenous and elastic fibers was nowhere shown by the naevus cells. In the vicinity of the naevus there was rather destruction than hyperproduction of the connective and elastic fibers.

Papillomata are perhaps of more frequent occurrence than other new-growths of the caruncle and plica semilunaris. Formerly literature included papilloma and other new-growths under the classification "polyps." According to modern pathological studies true polyps do not occur in the caruncle or conjunctiva; that is to say, hypertrophied out-growths containing all the elements of the conjunctiva have not been observed. The clinical and histological appearance of papilloma of the caruncle is the same as observed in the conjunctiva. It is a pinkish-gray, easily movable, corrugated mass, either single or multiple, and from one to several millimeters in diameter. Frequently one or two rather prominent blood vessels supplied to the growth are observed on the plica. Aside from slight irritation there are no marked symptoms unless, perchance, the tumor grows to an unusual size. Frequently a differential diagnosis between adenoma, hard and soft fibroma and sarcoma can only be made by the microscope. The growth is composed of a marked increase of epithelium covering a central core of fibrous tissue. The blood-vessels are comparatively large with greatly reduced walls which are frequently only endothelial. As a rule the papilloma is a superficial mass with an outward growth, rather than one invading the underlying structures. Rarely does it become malignant. *Treatment* is excision and cauterization of the base, or desiccation, which should be carried out thoroughly as they are subject to recurrence.

Posey (*Univ. of Penn. Med. Bull.*, Nov., 1901) removed and examined microscopically three small growths clustered at the inner canthus of a man aged 60 years. They had much the appearance of raspberries, but not so large. The largest was attached by a pedicle to the caruncle. The growth was extirpated by the method of Hasner, with satisfactory results.

Examination of specimens of the main growth arising by a pedicle on the surface of the earuncle shows the pedicle to be composed of fibrous connective tissue, the fibres of which run parallel to and surround the axial blood-vessels—four in number. The covering of the pedicle is composed of several layers of epithelial cells continuous with those of the earuncle. They contain similar goblet cells. The pedicle then branches, and as these branches proceed from the central stalk the axial connective tissue becomes less in quantity and assumes a more embryonal type, the fibrils being less closely arranged. They contain in their meshes numerous spindle-cells, with long fine processes and many polymorphonuclear leukocytes. The axial vessels are widely distended, and the vessel walls are composed of a single layer of en-



Papilloma of the Caruncle. Histological Detail of Caruncle, Showing Round Cell Infiltration. (Posey.)

dothelium. Surrounding these branching processes of newly-formed connective tissue, are thick mantles of epithelial cells which attain in places a thickness of twenty-five cells. The innermost cells are cylindrical, and the more external polygonal. The shape of the cells, however, has been much altered by the pressure of the contiguous cells and, as a consequence, many irregularities of form are assumed near the surface; they are flattened and the nuclei stain less well, although there is no horny layer nor evidences of beginning keratosis, such as is commonly found on similar tumors arising from the surface of the skin. In the masses of cells are many goblet forms or, more accurately, cells which have undergone mucoid degeneration. These are not confined to the surface layer, but can be found scattered throughout the growth, even in the deepest layers. In many places on the surface of the papilla there is, in addition, an infiltration with polymorphonuclear leukocytes. The growths arising from the palpebral conjunctiva

have exactly the same structure, consisting of axes of loose connective tissue branching from a central pedicle which are closely invested by thick mantles of epithelial cells. There is in no place any infiltration of the subconjunctival tissue with epithelial cells, and the tumor is to be classified as papilloma or, according to Virchow's designation, *fibroma papillare*.

Veasey (*Oph. Rec.*, Feb., 1905) observed in a man aged 27 years, a large cauliflower-like growth, 7 mm. in diameter, joined by a pedicle to the lachrymal caruncle and plica-semilunaris about 5 mm. distant from the caruncle. Attached to the pedicle of the caruncular growth by a strip of very hard, cartilaginous-like substance were two similar growths, each 4 mm. in diameter. They were of a pinkish color, seemed to possess but little sensation when touched, and the larger protruded from between the eyelids when the eye was closed. Two large veins, passing upwards and downwards on the plica from the caruncle, were also observed. Beyond a slight irritation to the conjunctiva occasioned by the presence of the growth, there were no other symptoms.

Sections showed many irregular, villous projections, composed of layers of stratified squamous epithelial cells. These were arranged around a central core of rather densely-woven, fibrous tissue containing within the meshes a few thickened blood vessels, the lumina of which contained fairly well-preserved erythrocytes. At another place within this epithelial area there was a stellate collection of red blood corpuscles contained within a finely granular matrix of fibrin. The corpuscles were quite well preserved and were evidently the remains of a hemorrhage. The central portion of the section was composed of a limiting layer of stratified squamous epithelium, surrounded by a broad area of coarse and fine, closely woven, fibrous tissue. Within its meshes, and approximating the epithelium, were several glands, probably sebaceous.

Gutmann (*Cent. f. pkt. Aug., Jan.*, 1908) reports three cases of *papilloma starting in the caruncle*. One was in a boy aged two and one-half years. It was excised and recurred, and on examination of the tumor removed 20 months after the first operation, it was found to be a benign papilloma. Another boy aged 7 years had a tumor that had been growing for 8 weeks. On close examination two others, the size of a pin-head, were found. In a third case a woman aged 31 years had a growth, noticed for about one year. These growths were also excised, and did not recur.

In a case of papilloma reported by Terrien (*Recueil. d'Opht.*, Nov., 1903) the tumor, consisting of an agglomeration of little papillary vegetations, recurred after twelve years without transformation into

epithelioma, which, Terrien thinks, confirms the view that papilloma is not a variety of epithelial cancer. Fromaget (*L'Opht. Prov.*, Vol. 10, p. 40) removed a growth of twenty years' duration. Microscopically it was a typical cauliflower papilloma with a characteristic histologic structure.

Among the more important papers on this subject are the following: Danis (*Bull. de la Soc. Belge d'Opht.*, No. 28, p. 22); Horner (*Klin. M. für Aug.*, 1871, p. 8); Parasotti (*Rec. d'Ophtal.*, 1884, p. 575); Elsenig (*Arch. f. Aug.*, 19, 1888, p. 63); Fuchs (*Arch. f. Aug.*, 20, p. 416, 1889); Schirmer (*Arch. f. Ophth.*, 37, p. 216); Wagenmann (*Arch. f. Ophth.*, 1894, 2, p. 250); Zimmerman (*Klin. M. f. Aug.*, 1894, p. 371); Grunert (*Klin. M. f. Aug.*, April, 1899); Lagrange and Mazet (*Annal. d'Ocul.*, 119, 1898); Testelin (*Dict. des sci. Méd.*, 1876); Hirschberg and Birnbacher (*Centralbl. f. pr. Aug.*, 1884, July); John E. Weeks (*N. Y. Eye and Ear Inf. Rep.*, Vol. 4, Jan., 1896).

Sarcomata are of distinctly infrequent occurrence in the earuncle and plica semilunaris. They present a firm, whitish-gray, flattened nodular, sessile or pedunculated mass which does not, as a rule, ulcerate. The growths contain blood vessels and round- or spindle-cells, held together by fibrous tissue. They may be pigmented or non-pigmented. Pigmented sarcomas are of more frequent occurrence; melanin being present in the cells and intercellular tissue. The point of predilection is the plica near the base of the earuncle. They may originate in nævi, or a lymphoma may show sarcomatous changes. They may be observed in youth but are more frequent in middle life. Complete removal is indicated and while their inclination is to remain local yet, if surrounding tissues, particularly the sclera, show evidence of invasion, immediate exenteration is imperative.

Emanuel (*Trans. Thirty-fifth Ophth. Cong.*, Heidelberg) reports a case in which a melanotic tumor started in the lachrymal earuncle and extended into the lower conjunctival sac. It was excised; one and one-half months later pigmentation returned, and at the end of a year there were two masses under the lower lid. Incomplete extirpation was done and followed, three months later, by exenteration of the orbit. One month afterwards optic neuritis appeared in the other eye, and the patient died in 6 months. The microscopic examination of the opticus showed minute nerve fibres which, however, could not be demonstrated among the melanotic cells. Emanuel discusses the possible relation of melanotic sarcoma to neuro-fibromatosis. Loring (*Oph. Rec.*, Vol. 19, p. 201) saw a small, slowly-growing, pigmented growth on the earuncle, suggestive of a melanosarcoma. Bock (*Cent. f. p. Aug.*, Nov., 1905) also records a case.

Syphilis of the caruncle. Occasionally one sees here the primary lesions, papules and indurations of this disease. In chancre there is marked pain; the caruncle is swollen, indurated, ulcerated and covered by a grayish crust.

TUMORS OF THE LACHRYMAL APPARATUS.

For the purposes of this section it may be stated that the *tears* are secreted by the lachrymal glands and conjunctival glands and flow over the eyeball whence they are guided into the *puncta lacrimalia*; thence into the canaliculi, the lachrymal sac and into (finally) the nasolachrymal duct and the nose.

The *lachrymal glands* are two in number and of unequal size. The larger portion, the lachrymal gland of the orbit, is situated in a depression in the orbital bone just under the ridge and near the external angle, and is attached by connective tissue to the periosteum. The smaller portion, the accessory lachrymal glands, composed of one large and many smaller ones, is situated in the loose tissue in the upper-outer portion of the upper lid. These glands have a lobulated structure composed of masses of tubular glands; the tubes are lined with a single layer of cylindrical epithelium.

The *puncta lacrimalia* are two minute openings in the canaliculi, one on the upper and one on the lower lid margin, near the internal canthus. The *canaliculi* run vertically for about two millimeters, then bend and run parallel with the lid margin for about one centimeter toward the internal canthus. These canaliculi converge and either open separately into the lachrymal sac or join to form a common duct. The *lachrymal sac* is situated in a fossa of the lachrymal bone at the lower inner angle of the orbit, and is covered by the internal canthal ligament. The upper end is rounded, while the lower is constricted and passes into the nasal duct. The duct is composed of fibrous and elastic tissue, the lining is a continuation of the conjunctiva above and the nasal mucous membrane below, and is covered with epithelium. We thus have in the lachrymal apparatus secretory and excretory functional parts.

Tumors of this apparatus are of comparatively infrequent occurrence, although both malignant and benign growths are encountered. Usually they are benign and of the mixed type. Among the commoner are cysts, myxoma, lymphoma, chondroma, dermoid, angioma, papilloma, sarcoma and carcinoma. Histologically, they may be designated according to the preponderance of the type of tissue, as fibroma, adeno-fibroma, etc. The majority of these growths cannot

be diagnosed except by the aid of the microscope. All lachrymal tumors that do not respond promptly to antisyphilitic or other indicated treatment should be removed, and then examined histologically. In the majority of cases there is no recurrence after thorough removal.

During the past seventeen years about seventy contributions to the literature of tumors of the lachrymal apparatus have been made. These papers include about eighty case reports under some thirty titles. The largest number of tumors described are of the mixed type; doubtless many others would fall under this class if a broad interpretation were placed on the microscopic findings. See, also, appropriate subsections of **Lachrymal apparatus**, p. 6930, Vol. IX of this *Encyclopedia*, but especially page 6984.

Greeves' (*Roy. London Ophth. Hosp. Reports*, Vol. 19, p. 237) communication, illustrated by typical cases, furnishes a useful *classification*. He says that tumors of the lachrymal gland may be divided into two main classes: (A) *Mixed tumors*. (B) *Tumors*, the main histological feature of which is an overgrowth of *small round cells in the gland stroma*.

Those belonging to (A) are never multiple. They occur in adult life, are of slow growth, do not recur locally if completely removed, nor do they give rise to metastases in the lymphatic glands or elsewhere. A fatal issue has been reported in some cases owing to the direct spread of the growth to the meninges. Mixed tumors are (1) encapsulated tumors, with gland tubules and interspersed lymphoid tissue-vessels large and thickened. Some show hyaline areas, while other areas resemble sarcoma. Cystic spaces occur in the center of the tumor and mitoses in the periphery.

(2) Fibrous capsulated tumors. In these some tubules are still present, while the growth proper is composed of irregular columns of large cells imbedded in a myxomatous stroma. The cells resemble epithelium. Some cystic spaces are found, but no mitotic figures.

(3) *Cylindroma* type. The capsule is entirely lacking; hyaline stroma is seen, with very few nuclei columns of epithelial-like cells, enclosing cavities. There are few blood vessels and some infiltration.

All tumors falling in Class A were endothelial in origin.

Class B.—All tumors of this class are similar, and are characterized by an invasion of the intra-alveolar stroma by small round cells. Of these (1) only one lachrymal gland is affected. The author's case proved to be malignant, whereas four similar cases reported in the literature were benign. 2. One lachrymal gland and one salivary gland are involved. 3. Both lachrymal glands are invaded, either with or without the involvement of one or more salivary glands.

Falling under this heading were nine cases. 4. There were three further cases of doubtful type.

It is possible that inflammatory and secondary enlargements of the gland are included among the cases in this group. Greeves says there is no evidence of the occurrence of true adenomata or adeno-carcinomata of the lachrymal gland. In this connection, however, the following history is given: A man, aged 31, had a tumor of the right lachrymal gland, which was removed and diagnosed as a myxomatous fibrochondroadenoma. After two years a relapse occurred and the new-growth was extirpated one and one-half years later after resection of the temporal orbital wall.

Haslinger (*Arch. f. Opth.*, Vol. 88, p. 28) emphasizes the fact that the great majority of tumors of the lachrymal gland belong to a uniform group and are almost always benign, although the histologic pictures may vary according to the preponderance of one or other component. Proliferating endothelium occurs in nests and tracts which in the arrangement and the form of their cells have a great similarity to epithelial elements. Haslinger assumes an endothelial origin for tumors of the lachrymal gland. He establishes an immediate transition from the endothelia of the capillaries into tumor cells. These are typical tumors of the lachrymal gland analogous to those of the parotid, which on account of their mesodermal origin were called by Borst, Volkmann, and others, "complicated tumors of connective tissue." He feels justified in applying this term to similar tumors of the lachrymal gland.

Greeves further reports the examination of a large number of these tumors. In practically all his cases he was able to find cornification and other characteristics of the ectodermal origin of these epithelial cells.

Adenoma of the lachrymal gland is rarely observed. It occurs more frequently in children than adults. It may be congenital or acquired, and is usually of slow growth. Rapid enlargement of the gland should arouse suspicion of malignancy or of a tuberculous tumor. It is a painless growth attaining at times considerable size, and the eye ball may be displaced down and in. C. Johnston, of Baltimore, described a case in which the growth was about the size of a hen's egg and contained dacryoliths.

If the growth is of moderate size and does not endanger the integrity of the eye, local treatment and internal medication with the iodides should be tried. If of rapid progress or causing serious inconvenience, it should be excised.

Brose (*Jour. A. M. A.*, Vol. 14, p. 515) observed, in a man aged 45

years, a tumor occupying the lachrymal gland region. There was no other glandular involvement. Sections of the excised mass showed the neoplasm to be made up of a stroma of connective tissue largely hyaline in character. Held in the meshes of this were found a number of gland tubules lined with columnar epithelium. These tubules were regular and lined with a single layer of epithelium, but in several areas there was a lack of regularity of the tubules. The epithelium was either in layers or growing in irregular masses without any distinct limiting membrane and with cells which showed mitosis. The diagnosis was *adenoma of the lachrymal gland* undergoing malignant changes.

Adenocarcinoma of the lachrymal gland. Collins and Mayou state that tumors arising in the lachrymal gland have been described as adenomata and carcinomata, but a more careful study of new-growths of this structure in recent years has shown that the large majority of them originate in its mesoblastic constituents.

Crampton gives the history of a woman aged 49 years, with adenocarcinoma originating in the lachrymal gland. She had always been healthy until five months before, when diplopia was noticed, and the following month the right eye became more prominent than the left, and there was ptosis of the upper lid. Gradually the eye was thrust forward to the nasal side and downward, until the ptosis measured 10 mm. The cornea remained clear, the pupil active, and the fundus apparently normal. Free excursions, except outwardly, proved that there was but little if any involvement of the muscle cone. On raising the lid, the apparently normal accessory gland came forward, but the gland itself could not be uncovered. A narrow, dense, growth extended forward 5 mm. beneath the upper-outer orbital wall. This mass had never been tender or painful. The vision was reduced to 6/60, while that of the left eye was 6/6. As there were several small tumors in the scalp, and a larger one (3 cm. in diameter) in the right axilla, the latter was removed as a diagnostic aid, and proved to be a fibroma. Later, the orbital tumor was found to be an adenocarcinoma originating in the lachrymal gland.

Microscopic sections from Reese's (*Arch. of Ophth.*, Vol. 48, p. 169) patient, a female, aged 37 years, showed adenocarcinoma of the lachrymal gland. Belt (*Wash. Med. Annals*, Vol. XII, p. 123) also reports an adenocarcinoma of the gland.

Angioma of the lachrymal gland has also been observed. The superficial veins are more or less prominent; there may be partial ptosis and displacement of the eye down and in or forward, and the growth increases measurably as the result of emotion. While usually observed

after birth it is quite likely that the elementary changes, at least, have occurred prior to birth. Frequently it is associated with malignancy. Complete removal and microscopic study are indicated.

Pes's (*Arch. of Ophth.*, July, 1908) case of angioma of the lachrymal gland was seen in an infant aged seven and one-half months. Swelling of the left eye had been noted for 4 months; occurring after the child had been crying. There followed dilatation of the superficial veins, slight ptosis, displacement of the eyeball down and forward and some limitation of upward motion. The tumor became apparent on raising the upper lid. On removal it was found to involve the orbital-lachrymal gland. Microscopic examination showed it to be an angiosarcoma.

Barlay's (*Zeit. für Aug.*, Sept., 1908) patient with angioma of lachrymal gland was a girl aged 3 years, in whom the protrusion of the eye had been noticed for 16 months. The exophthalmos was 3 to 4 mm. The tumor was removed by Krönlein's orbital resection, and proved to be a *hemangioma*.

Dacryops. Cyst of the lachrymal gland. This tumor, of rare occurrence, is occasionally present at birth, but, more frequently, is acquired. It forms a translucent, fluctuating tumor, varying in size from a pea to a hazel-nut. Upon everting the lid it is observed in the upper-outer fornix; at times extending into the orbit. Crying causes it to increase, while on pressure it collapses. These cysts may be uni- or multilocular. They are lined by cylindrical or flattened epithelium and contain lachrymal secretion. Excision is the proper method of treatment. See, also, p. 3730, Vol. V. of this *Encyclopedia*.

Cyst of the accessory gland is reported by Aufmwasser (*Ann. Ophth.*, Jan., 1913) in a woman aged 21 years who, two months earlier, had noticed a swelling in the right upper lid near the external canthus. On everting the lid (the patient looking down) a transparent cyst, the size of a large pea, came into view. It probably originated from the accessory gland.

Dermoid cyst of the lachrymal gland. The contents of this growth are those of the usual dermoid. The cyst itself is rarely *in*, but more often adjacent to the gland. It projects from the outer-upper angle of the orbit, and is covered by the normal skin. It is slow in growth, painless, and of the size of an almond. It is readily removed by incision through the skin. See, also, the heading **Dermoids**.

Endothelioma is an encapsulated, painless, slow growth, usually observed in early adult life and with small tendency to recurrence. The term is rather confusing, in that this type of tumor differs widely from the more malignant growth observed in other parts of the body.

Diversity of opinion exists as to whether it is of endothelial or epithelial origin.

In Wray's (*Trans. Ophth. Soc. U. K.*, Vol. 33, p. 77) case of endothelioma of the lachrymal gland there was partial ptosis for nine months. A swelling, occupying the position of the right lachrymal gland, was first noticed five months later; becoming larger, it closed the eyelids and caused the eyeball to be pushed downwards and directly forwards. There were no other glandular enlargements.

Epithelioma of the lachrymal gland is regarded as rare. Verhoeff, however, is strongly of the opinion that many tumors of the gland are of epithelial origin in that this organ is essentially an epithelial structure. Columns of epithelial cells with basement membrane, pearls and prickle cells have also been observed.

Jack (*Tr. Amer. Ophth. Soc.*, Vol. 12, p. 414) reports a case of tumor of the lachrymal gland in which an examination by Verhoeff showed the original growth to be of a congenital epithelial nature. The tumor was removed but returned a year later. At this time it was found that the growth had penetrated the roof of the orbit and had spread outside to the malar bone. Coley's serum having been given without effect, a radical operation was done, but failed to arrest the progress of the growth, and death resulted. The recurrent growth was similar to that often seen at the advancing margin of an epithelial carcinoma.

Granuloma. This growth contains granulation tissue with many thin-walled blood vessels, leucocytes, epithelial cells, and giant cells showing degenerative changes. There are very few reported granulomas of the lachrymal gland.

Moon (*Amer. Jour. Ophth.*, Aug., 1919) removed from a woman aged 53 years a mass in the region of the lachrymal gland. Syphilitic and tubercular tests were negative. Watters examined sections that showed fibrous elements, numerous blood vessels, large numbers of small, round cells and epithelioid cells in oval masses showing degenerative changes. He concluded that the condition was tuberculous. Verhoeff believed it to be a gumma, owing to the extensive necrosis and diffuse formation of granulation tissue. Mallory believed it suggested syphilis. The author concluded that the only tenable diagnosis is *infectious granuloma* as, after three years, there has been no clinical manifestation of syphilis, tuberculosis or malignant disease. See the figure.

Lymphomata. Symmetrical *lymphomata of the lachrymal glands* was first described by Mickuliez (*Berliner Klin. Woch.*, p. 759, 1888). It is a characteristic and symmetrical enlargement of both the lachrymal and salivary glands, chronic in character, of a non-inflammatory and

non-painful type, not associated with any demonstrable systemic disease. The condition may, however, be symmetrical, involving the lachrymal, frequently the accessory lachrymal glands, parotid and accessory parotids, submaxillary and, in many instances, the sublingual and preauricular glands. Tonsillar and adenoid enlargement has also been frequently noted.



Small round cells. Gland tubules.

Granuloma of the Lachrymal Gland. (Wells.) Section from center of gland showing diffuse inflammatory infiltration. (Moon.)

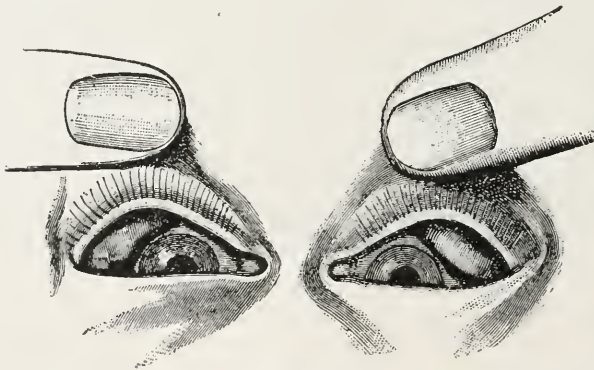
It exhibits a chronic, non-inflammatory, non-painful swelling, yet sometimes tender to pressure. As a rule the tumors are freely movable under the skin, although occasionally adherent to the underlying tissues. It affords a dense, firm sensation upon palpation. The facial appearance is quite characteristic—broad cheeks, enlargements in the submaxillary and parotid regions and drooping of the eye lids. For this latter appearance Zeigler uses the descriptive term of “blood-hound eye lids.” Upon everting the lid the enlarged, pendulous lachrymal gland is observed. (See the figures.) Nasal and pharyngeal

TUMORS OF THE EYE

disturbances are frequent accompaniments of this disease. In the absence of knowledge regarding a specific micro-organism, Zeigler concludes that the pathogenesis is probably chemotatic, thus causing a localized toxic hyperleucocytosis in the affected gland.



Mikulicz' Disease. Symmetrical enlargement of the lachrymal, parotid, and submaxillary glands. (Original case of Mikulicz.)



Mikulicz' Disease. Downward displacement of pendulous lachrymal glands. (Mikulicz.)

Mikulicz's description of microscopic section shows that the gland parenchyma plays a completely passive rôle. The enlargement consists solely in an enormous small-celled infiltration of the interstitial connective tissue. The preservation of a capsule and the interlobular septa are against a diagnosis of sarcoma.

Tuberculosis and syphilis are ruled out by appropriate tests; but

the possibility of lymphosarcoma, lymphoma and leukemic glandular swellings is to be considered in making a diagnosis.

The course of the disease is chronic but the prognosis is favorable despite relapse. *Treatment* consists in the removal of all respiratory obstructions, such as diseased tonsils, adenoids, the correction of enlarged turbinals and deflected septums. The internal administration of arsenic, iodides and pilocarpin is also recommended. Ziegler recommends thyroid extract.

Ziegler (*Trans. Amer. Ophth. Soc.*, 1909) cites two personal cases. These were colored; one a female, aged 18 years, the other a male,



Case of Mikulicz' Disease. (Ziegler.)

aged 34 years. In the former instance the duration of the disease was about six weeks. Convalescence covered a period of about two months following the removal of large soft tonsils. The second lasted about eighteen months. Retrogressive changes began to be apparent in the lachrymal glands, about one month after tonsillectomy.

Symmetrical lymphomata of the lachrymal glands (Mikulicz's disease) was observed by Posey (*Ophth. Rec.*, Vol. 25, p. 286) in a negro woman aged 21 years. Positive tuberculous and syphilitic reactions were obtained. Dental decay, with alveolar involvement, was present. Many of the glands of the body were palpable; a notable exception,

however, being the parotids. The masses corresponded to the site of the lachrymal glands, and extended under the superior surface of the horizontal plate of the frontal bone. The drooping curve at the outer angles makes one think of the eyes of a bloodhound. As no specific bacterin has been discovered, the author agrees with those who believe the condition to be probably chemotatic.



Lymphoma of the Lachrymal Gland. Enlarged Glands, Front View. (Posey.)



Lymphoma of the Lachrymal Gland. Enlarged Glands, Side View. (Posey.)

Ferro's (*Bol. Soc. de Oft. de Buenos Aires*, Vol. 3, p. 76; abst. *Ann. of Ophth.*, Vol. 25, p. 606) patient was a woman aged 44 years. She gave a history of rheumatism for three years. Examination of the teeth, pharynx, tonsils and nose proved negative. Both upper lids were swollen, corresponding to the position of the lachrymal glands. Both sides of the face and masseter muscles were also swollen.

Harbridge (*Amer. Jour. Ophth.*, Vol. 1, p. 418) observed symmetrical lymphomata of the lachrymal glands (*Mikulicz's disease*) in a colored girl aged 17 years. Many of the glands of the body were palpable, including the parotids. At the site of the lachrymal glands were large masses, causing the peculiar drooping of the angles of the lids.

Kayser (*Klin. Mon. f. Aug.*, July, 1909) observed a typical case, that presented no lesions other than tumor formation in the lachrymal

and salivary glands. There was nothing to suggest lues or tuberculosis; the blood was normal.

Randolph's (*Ophth. Rec.*, p. 18, 1904) case is interesting in that the enlargement of the lachrymal and parotid glands did not occur simultaneously. The parotids took no part in the process until the swelling of the lachrymal had disappeared.

Mikulicz's disease has also been reported by Meller and Snegireff (*Klin. Mon. f. Aug.*, Sept., 1906). The latter found excessive hypertrophy of the tonsils. After their removal, permitting better oxidation of the blood and the treatment of the nasal conditions, the lachrymal glands promptly returned to normal, the submaxillary and parotid glands recovering more slowly.

Moses (*Deutsche Med. Wochenschr.* 34, 1909) reports a case occurring in a man of 61. See, also, **Mikulicz' disease**, p. 7703, Vol. X of this *Encyclopedia*.

Mixed tumors of the lachrymal glands. In the lachrymal gland is found a group of tumors the origin of which has long maintained an active controversy. These are of complex structure, usually presenting epithelial elements in the form of cell strands, alveoli, or diffuse masses; and mesoblastic tissues, chiefly cartilage, mucous tissue, and cellular connective tissue. Any one of these elements may predominate, showing nearly pure chondromas, sarcomas, or carcinomas; but usually all the cell types are represented.

These tumors were originally regarded as carcinomas, and while Virchow derived the cartilage from the connective tissue by metaplasia, Cohnheim regarded them as derivatives of remnants of the branchial arches. The epithelial nature of the tumors was undisputed until C. Kaufmann, on the strength of peritheliomatous and sarcomatous features, placed them among the sarcomas.

In many instances a long period of inactivity precedes the active development of the growth. Once progress is established it proceeds slowly, yet in certain histological types the advance is more rapid. In other instances, following a period of activity, the growth may remain stationary for long periods of time. Occasionally the growth is steadily progressive from the first. Thus there is wide variation in the clinical behavior of these tumors.

The encapsulated growths do not, as a rule, recur after surgical intervention. Radium might be useful in the treatment of these conditions, in view of their uncertain progress; and because of the recurrence with increasing malignancy which follows surgical interference.

Birch-Hirschfeld (*Graefe's Archiv für Ophth.*, Vol. 90, p. 110) describes a *lachrymal tumor* four years after it had been noticed by

the patient, a man aged 57 years. There was marked exophthalmus and displacement of the eyeball downward and inward. The corrected vision of this eye was $1/4$. The tumor was the size of a hen's egg. A few months after removal of the tumor the visual acuity and the position and mobility of the eye had returned to normal; and a marked astigmatism due to the pressure of the tumor itself disappeared. There was no sign of recurrence six years after the operation. The new-growth was a typical mixed tumor of the lachrymal gland, its appearance under the microscope in different areas being respectively that of adenomyxoma, chondro-myxo-sarcoma, carcinoma and cylindroma. Birch-Hirschfeld believes that (1) a large number of tumors which have been observed in the lachrymal gland and in its direct vicinity, and which have been described under various names, can be grouped under the single designation of mixed tumors. (2) These tumors are distinguished anatomically by a very complicated structure. They contain epitheloid cells, which are arranged as glandular formations, reticular chains of cells or solid cellular columns. At times they correspond morphologically to true epithelium, presenting a basal membrane, typical intercellular trabeculae; and, occasionally, signs of keratinization. The varying relations of these parenchymatous cells to the surrounding stroma, which is sometimes mucoid and sometimes contains islands of cartilage, give rise in some areas to the picture of an endothelioma; in others to that of a typical cylindroma, and again in others that of an adenomyxoma or chondromyxoma. (3) The epithelial nature of these parenchyma cells appears to Birch-Hirschfeld more probable than their endothelial origin, and he is led to this view especially by a study of the mixed tumors of the salivary glands, with which those of the lachrymal glands show a striking correspondence. (4) The mixed tumors of the lachrymal gland are at first distinguished clinically by slow growth, but may suddenly grow rapidly and become malignant, in the sense that they lead to local recurrences and to the formation of metastases. (5) Early and complete removal of these tumors is therefore indicated. (6) In great probability, mixed tumors of the lachrymal gland, as well as those of the salivary glands, take their origin in a germ deposit due to disturbance of development, perhaps in the third embryonic month, when the primitive tissue of the lachrymal gland enters into relationship with the primordial cartilage of the frontal bone.

Geo. H. Knapp (*Arch. of Ophth.*, Jan., 1919) describes a *mixed tumor of the lachrymal gland* as almost spherical in form, of firm consistence and its greatest diameter as measuring 20 mm. The

growth was encapsulated and consisted of a stroma of loose fibrous tissue and a parenchyma made up of cells approximately of the endothelial type, having a large, homogeneous, evenly-staining nucleus, and arranged in the form of long strands or closely packed in groups having a rounded outline, or having an arrangement resembling that of the acini of the normal lachrymal gland.



Adenocarcinoma of the Lachrymal Gland. Case I. Before operation. (Holloway.)

Case I. Four months after operation. (Holloway.)

A mixed tumor of the lachrymal gland is described by De Laperousse (*Arch. d'Opht.*, Vol. 32, p. 401). The patient was a man aged 36 years, and the tumor had grown very slowly for seven or eight years. It proved to be composed of myxomatous and cartilaginous tissue, without any bone.

Perrod (*Ann. di Ott.*, Vol. 40, p. 513) studied a growth to which he gives the name of *lymphangio-endothelioma of the lachrymal gland*. The patient, a man aged 50 years, had only noticed the tumor for a



Case I.



Case I.

Adenocarcinoma of the Lacrymal Gland. Showing epithelial pearls, small amount of fibrous stroma with diffusion of mucin in places, appearance of myxoma and round cell sarcoma. (Holloway.)

few months. It was removed, but the man died a year later of a local recurrence which involved the upper maxilla.

Holloway (*Trans. Amer. Ophth. Soc.*, Vol. 14, p. 542) observed a mixed tumor of the lachrymal gland, in a man aged 35 years. The left eye was displaced downward 6 mm. and inward 4 mm.; the prominence measured 27 mm. as compared with 17 mm. of its fellow. The mass measured 3.75 cm. in length and 2.5 cm. in width, and extended from the middle of the upper lid to the outer canthus. The growth was removed through a curved incision at the eyebrow. Six weeks later the palpebral fissure measured 11 mm., its fellow 10 mm., the prominence 18.5 mm., its fellow 17 mm.; rotation outward within 2 mm. of the canthus, its fellow 1 mm. While the growth is an example of so-called mixed tumor, Allen J. Smith, who examined the specimen, prefers to look on it as an *adenocarcinoma*. The writer points out the interesting clinical feature of a decided deformity of the upper, outer, margin of the orbit indicating a long-continued pressure.

Weigelin (*Klin. Mon. f. Aug.*, Sept., 1908) observes that tumors of the lachrymal gland are mostly mixed forms, resembling in this respect tumors of the parotid and submaxillary glands. Whereas lachrymal neoplasms were formerly supposed to be mostly carcinoma, the tendency now is to look upon sarcoma as the more prevalent form.

Pfingst (*South. Med. Jour.*, Vol. 11, p. 587) removed from a man aged 48 years a slowly developing growth of the lachrymal gland, weighing three and one-half drams. It resembled histologically neoplasms of the salivary gland, spoken of as mixed tumors. It was encapsulated and contained structures found in normal lachrymal glands, there being a preponderance of fibrous tissue which had undergone myxomatous changes and, in some of the larger spaces, a pearl-like arrangement. These tumors occur in adult life, are of slow growth, do not recur, are not associated with enlargement of the lymphatic glands and have never been known to exhibit a general metastasis.

Katz (Graefe's *Arch. f. Ophth.*, Vol. 74, p. 294) records three cases of mixed ectodermal and mesodermal tumors in the region of the lachrymal gland, all of which occurred in adults. They developed relatively slowly, and reached moderate size. In none of them was there a recurrence.

Elliot and Ingram (*Ophthalmoscope*, Feb., 1914) report a series of tumors of the lachrymal gland, with careful clinical and pathological studies of each. One was a typical mixed tumor, others contained spindle-celled sarcomatous, small, round-celled sarcomatous,

fibrous and endotheliomatous changes as their predominant features. The first, a female aged 18 years, presented a firm growth, measuring 43 mm. by 35 mm. by 23 mm., just under the external orbital rim. It could be slightly displaced. The tumor was successfully removed but there was an inoperable recurrence two years later. Sections revealed a soft, cartilaginous, encapsulated growth. The authors, therefore, are inclined to class it as a mixed tumor similar to neoplasms of the parotid gland. The presence of Altmann's granules,



Mixed Tumor of the Lachrymal Gland. The tumor as seen from the front.
(Elliot and Ingram.)

in spite of immersion in formalin solution, makes it highly probable that the cells were of epiblastic origin, since mesoblastic cells, after treatment with formalin, do not in the author's experience, show Altmann's granules. (See the figure.)

A female, aged 3 years, presented a rapidly-growing mass that protruded between the lids. It was a hard, irregular growth, apparently situated in the lachrymal gland. There was no preauricular or neck gland involvement. Removal was followed two months later by an inoperable recurrence. Sections showed the tumor to be composed of interlacing bundles of spindle-cells of varying size interspersed with a variable amount of fibrous connective tissue. The

diagnosis rested between a fibroma and a spindle-celled sarcoma. On account of the nature of the cells and the presence of thin-walled, ill-formed blood vessels it was probably a spindle-celled sarcoma.

A female, aged 3 years, presented bilateral growths in the lachrymal regions. The tumors were very distinctly divided, strongly suggesting the division into the main and accessory parts of the lachrymal glands. The antra of Highmore were involved; as the case was inoperable no opportunity for microscopic study was afforded.



Mixed Tumor of the Lachrymal Gland. Showing the mass evidently representing the accessory portion of the gland. (Elliot and Ingram.)

A male, aged 35 years, presented a large, soft mass in the lachrymal region that appeared rather suddenly two months previously. Krönlein's operation was performed. The growth lay outside the muscle cone and obviously originated in the lachrymal gland. No trace of that gland could be found apart from the tumor. Pathological examination indicated that it was probably syphilitic in nature; but there was a recurrence 10 months later which was not affected by iodides.

A female, aged 9 years, presented a hard mass in the region of the left lachrymal gland. During the ensuing six months the growth distinctly increased in size despite the use of mercury and iodides. Krönlein's operation was performed, and a mass reaching almost to

the apex of the orbit was removed. There was a recurrence two months later followed by death. Sections showed a fibrous stroma, forming an irregular net-work in which lay numerous small, round-cells; there were few blood vessels. A diagnosis of *small, round-celled sarcoma of the lachrymal gland* was made.

A female, aged 30 years, presented a soft, vascular tumor in the upper outer angle of the left orbit, which was exenterated with satisfactory results.

A thorough examination was made of a large number of sections of this tumor. It proved to consist of irregular, branching columns



Malignant Tumor of the Lachrymal Gland. (Elliot and Ingram.)

and masses of cells embedded in a matrix of loose fibrous tissue. The cells were nearly all degenerate. No trace of glandular tissue could be found. The authors are of opinion that the tumor was an endothelioma and that it originated in the lachrymal gland.

Myxoma of the lachrymal gland. This is an encapsulated tumor with gland tubules interspersed with lymphoid tissue and vessels, large and thickened. There are some hyaline areas (while other areas resemble sarcoma); cystic spaces in the center of the tumor and mitoses in the periphery. The growths, as a rule, extend far back into the orbit; and also, as a rule, they originate in the accessory gland; they follow a rapid course and are prone to recur after removal.

Sarcoma of the lachrymal gland is usually observed past middle life. At first it is rather slow in growth; later, degenerative changes take place, the mass passing beyond the confines of the gland capsule. The growth is then rapid and invades the surrounding structures. Many authorities do not consider this neoplasm of a high

degree of malignancy. Early and complete removal is indicated. In the large majority of instances there is no recurrence. See, also, p. 11545, Vol. XV of this *Encyclopedia*.

Copez (*Arch. d'Ophth.*, Jan., 1903) reports three cases of sarcoma of the lachrymal gland, all extirpated by a Krönlein operation. In two there was no recurrence at the end of 5 and 3 years, respectively. In the third case the parotid gland of the same side was also involved. Both masses were removed, but the corresponding cervical glands were found involved 18 months later.

Wells and Mayou (*Tr. Ophth. Soc. U. K.*, Vol 30, p. 97) report a round-cell sarcoma of the lachrymal gland in a woman aged 66 years. The growth was encapsulated. There were no signs of degeneration but mitosis was marked. The characteristics of these tumors are that they occur late in life, are of very slow growth, do not tend to infiltrate rapidly, and do not lead to glandular enlargements.

Tucker (*Brit. Med. Jour.*, 1, p. 1220); Goldzieher (*Centralbl. f. prakt. Aug.*, March, 1906); Napp (*Cent. f. p. Aug.*, Jan., 1910), and Alger (*Arch. of Ophth.*, Vol. 48, p. 372) have also reported cases of sarcoma of the lachrymal gland.

Gendron and Servel Lorient (*Archives d'Ophthalmologie*, Sept., 1905) report that a patient, a young man aged 18 years, three months before he came under notice, observed a slight exophthalmos with diplopia. The exophthalmos increased until the eye could not be completely closed; the movements of the ball were almost abolished, and a tumor could be felt extending from the external angle to the middle of the superior margin of the orbit. The tumor was removed by the Krönlein operation; it was found to extend to the bottom of the orbit. Six months later the patient died, as the author believes, of intracranial metastasis. The tumor was encapsulated and microscopic examination showed it to be a lymphosarcoma. The authors conclude that the neoplasm sprang from the inner face of the capsule normally enclosing the orbital lachrymal gland. During the process of growth the capsule was merely distended, save posteriorly, for a limited area, where the microscope demonstrated that there was a zone of invasion of the tumor elements into the neighboring tissues. Apparently this was the route by which the growth had reached the base of the brain.

Alger (*Arch. of Ophth.*, July, 1919, p. 372) reports the removal of a sarcoma of the lachrymal gland with no recurrence in five years. The growth had been noted four years previous to operation. It was enclosed in a thin capsule which ruptured, but both the gland and its accessory were removed. The record of this case bears out the

contention of several writers that adenosarcoma of this type has a very low malignancy.

Mendez (*Klin. Mon. f. Aug.*, 1910, p. 541) removed a tumor of the tear gland in a woman 77 years of age. It consisted principally of myxomatous and sarcomatous tissue; so poorly differentiated in places that it gave to the growth the appearance of a myxosarcoma. There were traces of epidermis and of glandular tissue; numerous cysts, as well as fibrous tissue which had in part undergone hyaline degeneration, were also present.

Tuberculoma of the lachrymal gland is a firm, movable tumor (in the region of the lachrymal gland) about the size of an almond. In the early stages it is painless; occasionally the overlying skin is red and swollen when it is accompanied by pain; and usually there is a tuberculous focus in some other part of the body. Sections show typical miliary tubercles with round-cell infiltration. The tubercle bacillus is not usually found; caseation has not been observed. Medical and hygienic measures should be tried and if unsuccessful surgical measures adopted.

Würdemann (*Amer. Jour. Ophth.*, Vol. 2, p. 201) removed from a woman, aged 42 years, bilateral tuberculomata of the orbital lachrymal glands. The palpebral glands were also removed. The masses measured 3 by 2 by 1 cm.; sections showed more or less dense, small round-celled infiltration. Ideal microscopic tubercles consisting of epithelioid cells, giant cells and small celled infiltration were observed.

Ormond (*Trans. Ophth. Soc. U. K.*, Vol. 30, p. 107) removed a tumor of the lachrymal gland; and notwithstanding that histologically it appeared to be a simple hypertrophy, after exenteration of the orbit tumors appeared in the abdomen, arm and thigh. Van Duyse (*Bull. de la Soc. Belge d'Ophth.*, No. 29, p. 27) reports a case of *mixed epitheliomatous tumor* springing from between the palpebral and orbital lachrymal glands.

The following cases are also in the literature of this subject: Rollet (*Ophthalmoscope*, Feb., 45, 230) (lymphoma of the episclera and lachrymal glands); Schultze (*Klin. Mon. f. Aug.*, 1903) (epithelial tumors of the lachrymal gland); Terson (*Arch. d'Ophth.*, 33, p. 430), (a prelacrimal tumor); Skenn (*J. Am. Med. Ass'n.*, Oct. 29th, 1903) (fibro-adenoma of the lachrymal gland); Stieren (*Trans. Amer. Ophth. Soc.*, Vol. 10, p. 323) (cystadenoma of the lachrymal gland).

Tumors of the lachrymal sac are rare. That reported by Pasetti (*Ann. di Ott.*, Vol. 42, p. 55, 1, ill) is one of six cases of *epithelioma*

of the lachrymal sac to appear in the literature. The patient was a man aged 73 years, who had noticed the growth for a year. Clinically it appeared as a swelling the size of a large walnut in the region of the sac. During its removal it was possible to isolate the growth perfectly in every direction, there being no adhesion to the skin. The patient died six months later of an independent cause. Microscopically the tumor proved to be a cylindric-celled carcinoma derived from the cylindric epithelium of the mucosa of the sac. Rollet (*Arch. d'Ophth.*, June, 1905) reported a cancer of the lachrymal sac. Maggi's (*Ann. di Ottal.*, Vol. 35, Fasc. 10, 11, 1906) case was a primary tumor of the lachrymal sac.

Wood (*Proc. Path. Soc., Phila.*, Vol. 16, p. 83) described a tumor of the nasolachrymal duct which followed forcible dilatation. The tumor could be enlarged by inflation through the nose. Upon excision, it was found to consist of connective tissue, with many small, empty cysts lined by epithelioid cells. A few giant cells were present and these were considered evidence of the inflammatory nature of the condition. Urayama (*Nippon Gank. Zasshi.*, Sept., 1917) compares an instance of *lymphoma of the tear-sac* with elephantiasis of the upper lid. Sulzer and Ducloux (*Rec. d'Ophth.*, June, 1906) met with a case of bilateral lymphoma of the lachrymal sac without any evidence of leukemia.

A *papilloma of the upper canaliculus* measuring 10 mm. by 4.5 mm. was easily removed by Juler (*Arch. of Ophth.*, Vol. 44, p. 564) after slitting the canaliculus. It apparently had no pedicle.

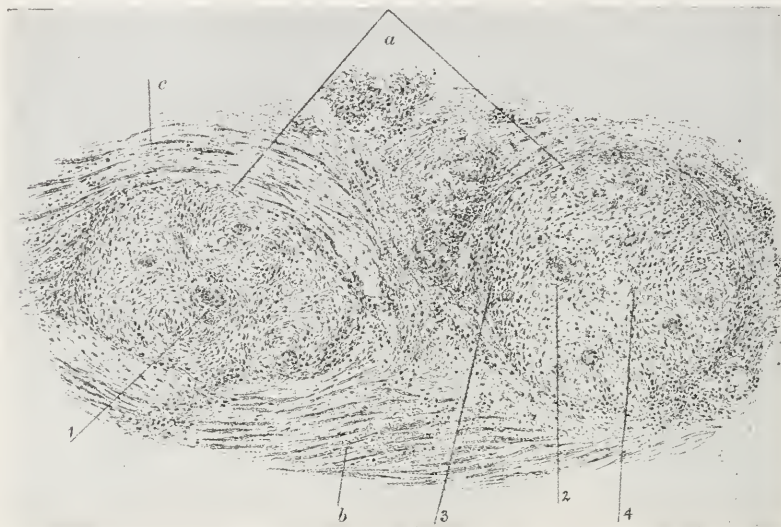
Verhoeff and Derby (*Arch. of Ophth.*, Vol. 44, p. 252) report a case of *plasmoma of the lachrymal sac*. Along the tarsus of the left lower lid was a flat, yellowish growth 6 by 3 by 1 mm. The caruncle was enlarged and surrounded by a yellowish, waxy border. The tear-sac showed enormously thickened walls composed of very large plasma cells. It contained both small and large, irregular, masses of hyalin material which showed a definite relation to the blood vessels. Nine published cases of plasmoma of ocular structures are referred to; the above, however, is the only case of lachrymal sac involvement reported in the literature.

The condition, however, is not as rare as this fact would indicate, for plasmoma is the early state of hyalin and amyloid degeneration of the conjunctiva.

A *sarcoma of the lachrymal sac* was reported by Butler (*Arch. of Ophth.*, Vol. 43, p. 16). The circumcystic tissue was edematous, but no pus appeared for almost a month. Incision showed a round, well-defined tumor about 2 inches in diameter, which proved to be a small

round-celled sarcoma. The tumor recurred in the orbit and after each excision tended to return in another area, but close to the original site. Although the malignancy was low, the patient died within a year from multiple metastases. Snegireff (*Viestnik. Ophth.*, 27, p. 686) also describes a sarcoma of the lachrymal sac. See p. 11545, Vol. XV of this *Encyclopedia*.

de Schweinitz (*Trans. Amer. Ophth. Soc.*, 1898) removed from the prelachrymal sac region a growth, eight by four mm., with the histological characters of tubercle. The growth was partly surrounded by, and partly within, the muscle fibers and their associated



Prelachrymal Tuberculous Tissue. (Zeiss' Ocular 8, obj. 16 mm.)
a, Small tubercles, containing: (1, 2) giant cells, (3) lymphoid cells, (4) epitheloid and oval granular cells. *b*, *c*, Muscle fibres. (de Schweinitz.)

fibro-fatty tissue. Blood vessels, at least new-formed ones, were absent.

More particular examination shows that this tissue tends to assume a definite formation composed of minute nodules or tubercles, as seen in the accompanying figure. The nodule is circular or slightly oval in shape and is surrounded by muscle fibers. At its periphery the cells, usually lymphoid, are more closely aggregated than in the intermediate and central parts, where, in addition to these cells, other varieties — oval, spindle, and epitheloid — appear, while scattered through the nodule are giant cells, not only centrally but peripherally also. As many as a dozen giant cells may be counted in a single

nodule. In other portions of the section the tissue is composed of a nearly uniform expanse of small, deeply-stained cells resembling the so-called tuberculous granulation tissue, but even within this material it is usually possible to recognize the tubercles by the presence of epithelioid and giant cells. While there is no nodule which exhibits caseation at its center, spots appear here and there which suggest beginning degenerative changes. Independently of the interest which attaches to this small growth, on account of its resemblance to tubercle, is its situation. Prelachrymal sac-disease is never common. We are accustomed to observe abscesses in this situation associated with caries of the lachrymal bone, either as the result of injury or from syphilis, and cysts are also described, but a solid growth of this character is probably unique. Of course, it must not be confounded with the growths which appear in this region and have their origin in the lachrymal sac.

Tuberculous tumors of the lachrymal sac may readily be overlooked, since they may present the usual symptoms of dacryocystitis. In 46 extirpations of the sac, Rollet (*Rev. Gén. d'Oph.*, June, 1903) encountered it four times. In these cases, although inoculation of the guinea-pig demonstrated the presence of the bacillus and there were evidences of tuberculosis elsewhere, the local disease appeared to be permanently cured by operation of removal.

TUMORS OF THE CONJUNCTIVA.

This subject has to some extent been treated on p. 3068, Vol. IV of this *Encyclopedia*.

For the purposes of this section, the *conjunctiva* may be regarded as a sac open only at the palpebral fissure. It is a mucous membrane, covering the lid margin, posterior surface of the lids, and is reflected to the globe, there covering the sclera to the corneal limbus. From the limbus across the cornea it is represented by a single layer of epithelium. It may, therefore, be divided into the fold of transition, marginal, tarsal and bulbar conjunctiva. The character of the epithelium, which is typical in the new-born, changes in later life, no doubt owing to the irritating effect of exposure. There is a histological difference in the conjunctiva in different parts, which explains the limitation of certain pathological conditions to definite regions.

In the marginal area, extending for a short distance in the tarsal region, the epithelium is stratified. In the intermarginal area (the transitional zone) the prickle-celled appearance of the epithelium resembles epidermis rather than mucous membrane. The marginal and tarsal conjunctiva is firmly attached to the neighboring tissues

and is composed of stratified, cylindrical and goblet cells. This part contains the small tubules of the glands of Krause. The surface shows minute papillæ containing fine blood vessels between which the epithelium dips somewhat.

The *transitional fold* is that portion which is reflected from the lids on to the globe. There is an abundance of conjunctival tissue which contains elastic fibres, and which is covered by stratified and cylindric epithelium. Under the epithelium are adenoid tissue, lymphatic cells and minute follicles. There are no papillæ.

The *bulbar conjunctiva*, which extends from the fold of transition over the sclera to the limbus, is attached to the globe by loose connective tissue, so that it is easily raised or moved from side to side. In the region of the cornea it is more firmly attached. It is translucent, permitting the white sclera to show through. In elderly persons it has a dull, yellowish appearance in that area opposite the palpebral fissure.

All parts of the conjunctiva are well supplied with blood vessels and lymphatics. The epithelium of the conjunctiva at the limbus, which is considerably thinned, is continuous with the epithelium of the cornea.

Nakagawa (*Arch. of Ophth.*, p. 429, 1908) has undertaken a study of the *papilla of the normal conjunctiva*, examining for this purpose the conjunctiva of man and domestic animals. The palpebral conjunctiva does not contain papillæ, but they are found in the neighborhood of the cornea, and he has made the interesting observation that in old persons they become larger and subdivided, and therefore he explains the predilection of this region for carcinoma. In the early stage of carcinoma at the corneo-scleral junction these papillæ undergo hypertrophy, and burrow into the depths of the tissues.

During the past seventeen years about two hundred contributions with studies of about two hundred and twenty-five case-reports of tumors of the conjunctiva have appeared in the literature. Many of them are of great merit and worthy of far more consideration than the limits of a short abstract will permit. About one-third of these growths were malignant; about one-fourth were congenital.

It is important to differentiate by accurate clinical and histological investigation, the different types of growths to which this tissue is subject.

Adenoma of the conjunctiva occurs only in connection with the tarsus—from Krause's glands or from the caruncle. The growth contains gland lobules, granulation tissue, a few cystic spaces and a small amount of fibrous tissue.

Angiomata of the conjunctiva are congenital and increase slowly in size, after birth. They are of red or bluish color, movable with the conjunctiva and of a telangiectatic or cavernous form. They may be partially emptied of blood by pressure. These tumors are rarely primary but usually involve the conjunctiva by extension from the skin of the lids or from the orbit. They are composed of convoluted capillaries and a small amount of connective tissue; some sections show wide, endothelial-lined blood spaces traversed by connective tissue. If the connective tissue is considerable they are termed angio-fibromata. See, also, p. 3006, Vol. IV of this *Encyclopaedia*.

There are several methods of treatment—excision, alcohol injections, electrolysis, ligature and desiccation.

James and Trevor (*Brit. Jour. of Ophth.*, Vol. 2, p. 129) report the clinical histories of two cases of *hemangioma of the palpebral conjunctiva*, that formed pedunculated tumors. One patient was a youth, aged 17 years; the second a girl, aged 13 years. The term “nevus” used in the pathologic reports on these two cases has been applied to tumors of which a strictly correct title is *hemangioma simplex*. The term *naevus* is commonly applied to vascular tumors without regard to their more intimate structure. It is generally agreed that a simple vascular *naevus* is a congenital malformation rather than a true neoplasm. The two cases described belong to the class of true blastomas, and consist of large endothelial cells arranged in many layers around spaces or tubules containing blood. In both cases the growths were slightly lobulated, the second case more than the first. In both there was an irregular area around the periphery of the tumors; the second case bearing on the outside the patchy remains of a covering of several layers of flattened cells belonging to the palpebral conjunctival epithelium. The authors found surprisingly few references in literature to similar cases.

Angioma of the conjunctiva of traumatic origin was observed by Marin (*Arch. de Oft. Hispano-Amer.*, Vol. 17, p. 325). A female, aged 52 years, had, four years previously, injured the superior cul-de-sac with a stick. A mass appeared about the size of a small hazelnut. The outer part of the palpebral opening was occupied along almost its whole length by another growth of the size and shape of an almond. The two swellings were parts of the same tumor. A complete cure was obtained in three treatments with bipolar electrolysis at intervals of about three weeks.

Gerlach and de Kleijn (*Nederl. Tjd. V. Geneesk.*, 1, p. 402) report a case of *varices of the conjunctiva* in which the diagnosis was con-

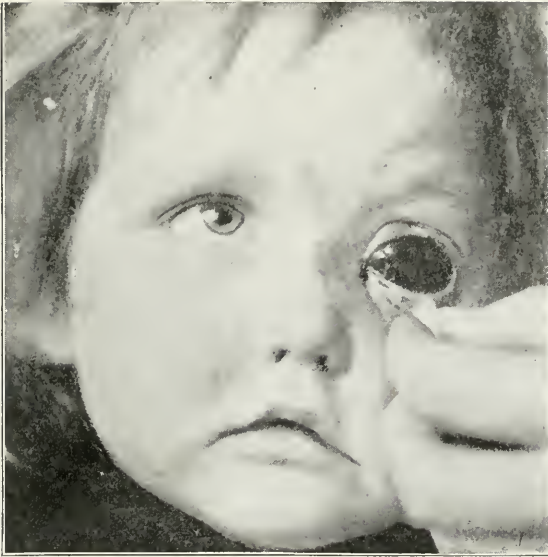
firmed microscopically. There was a congenital, reddish-blue tumor involving the lower outer part of the bulbar conjunctiva.

Of Casolino's (*Arch. di Ott.*, Vol. 21, p. 206) three cases of conjunctival angioma, one involved the tarsal conjunctiva of the lower lid, and two the external aspect of the bulbar conjunctiva. The history of the first case dated back only one year, while the bulbar tumors were said to have been present at birth.

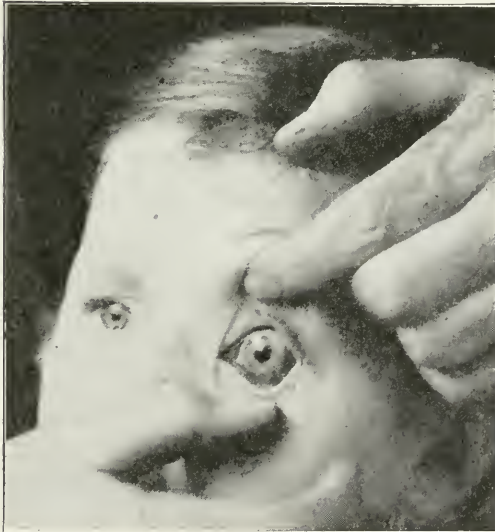
Carlini (*Ann. di Ott.*, p. 396, 1905) added one case to the sixteen recorded cases of true *conjunctival angioma*. A lad aged 5 years had a reddish-brown growth the size of a nut attached by a pedicle to the tarsal conjunctiva. It was removed three times before recurrence ceased.

A woman, aged 36 years, seen by Adams (*Trans. Ophth. Soc. U. K.*, Vol. 32, p. 289), had, above the cornea of her right eye, a red spot which had been noticed for four years. It was increasing in size, and was surrounded by a zone of subconjunctival hemorrhage. The amount of free blood varied much from time to time, but always seemed more after the patient had been much out of doors. Microscopic examination showed the growth to be a *fibrous angioma*.

Gifford (*Ophth. Rec.*, Dec., 1906) successfully treated an angioma of the conjunctiva by *injections of absolute alcohol*. He found that only 58 cases, including his own, had been reported. The left eye was apparently pushed out by a dark-red, lobulated tumor which extended from the caruncle to $\frac{3}{16}$ of an inch beyond the center of the corneal margin above and below, reaching to the fornices but not invading the palpebral structures. He injected two or three drops of absolute alcohol into various parts of the tumor. The injected portions at once assumed a pale, grayish-pink color, and after a week or ten days the tumor was much reduced in size. The injections were then repeated, the needle being carried, part of the time, $\frac{1}{2}$ inch into the orbit along the inner side of the globe. After this, alcohol was injected every two or three weeks for the next two months; at the end of this time the original tumor had practically disappeared, but now the conjunctiva from the outer third of the corneal margin to the external canthus, which had seemed normal, became dark-red and he began to fear an extension of the growth around the deeper portions of the globe, so more alcohol was injected, $\frac{3}{4}$ inch deep, along the inner wall of the globe and $\frac{1}{2}$ inch deep into the upper and lower fornices. After this the improvement was steady, and when the patient went home there was no swelling visible; the only trace of the former trouble being a moderate congestion of the inner half of the conjunctiva, which steadily improved.



Angioma of the Bulbar Conjunctiva. (Gifford.)



Gifford's Case of Angioma of the Conjunctiva After Treatment by Injections of Absolute Alcohol.

The injections were always made under light chloroform anesthesia and were followed by only moderate swelling and very little pain; at no time was there any sign of breaking down or necrosis of the surface. During the whole course of the treatment the only symptom that caused the least anxiety was a swelling of the left side of the face, which developed two or three days after the last deep injections into the orbit. The patient seemed depressed and the cheek below the zygomatic process was quite puffy for several days; but this all cleared up without any special treatment.

Among other contributions may be mentioned those of Mayou (*Trans. Ophth. Soc. U. K.*, Vol. 33, p. 55) who reported a pulsating angioma of the conjunctiva in a woman of 63 years; Castelain (*Rec. d'Ophth.*, July, p. 429, 1906) who reports two cases of conjunctival angioma: Lurje (*Klin. M. f. Aug.*, March, 1908); Ancona (*Ophthal.*, July, 1908); Herrenschwand, F. (*Klin. M. f. Aug.*, Vol. 60, p. 840) and L. Schmitt (*Wurzburg Diss.*, 1918).

Carcinoma of the conjunctiva. See, *infra*, *Epithelioma of the conjunctiva*.

Cysts of the conjunctiva are more or less sharply-defined, thin-walled prominences containing yellow, watery fluid. They are superficial, movable, and may be single or multiple. There are three main varieties. The first type includes those tumors that originate from ectatic lymph vessels and are usually confined to the bulbar conjunctiva. They may be sessile or pedunculated, uni- or multilocular.

A second type results from inflammatory changes, in which an ingrowth of epithelium occurs, or a fold of conjunctiva, such as one finds in pterygium, fuses over; the enclosed cells then degenerate, with the formation of a cyst. To this type may be added those retention cysts which result from obstruction to the openings of such glands as Krause's. The third type follows injury; cystoid cicatrix after cataract operation is a good illustration. They may all be treated by incision and cauterization, excision or desiccation. See under **Cysts**; as well as p. 3013, Vol. IV of this *Encyclopedia*.

R. L. Oatman (*Arch. of Ophth.*, May, 1904), in a study of *epithelial cystoma of the conjunctiva*, concludes that the dermoepithelioma of Parinaud is not a special neoplasm, but should be regarded as a transitional stage occurring in the development of most epithelial cysts of the conjunctiva. Inasmuch as the term epithelioma has long been synonymous with carcinoma, it should never be used to designate a non-malignant growth, and he therefore suggests the term epithelial cystoma of the conjunctiva. The progressive steps in the development of *epithelial cystoma* are thus recorded by this author: (a) As

a result of some inflammatory or other tissue irritant, the deep epithelium of a crypt or fold in the conjunctiva proliferates and forms cellular masses in the conjunctival tissue. There is also an inward proliferation of the surface epithelium irrespective of surface indentations. The latter process is probably a secondary one. In this stage the tumors resemble carcinoma and have been recorded as such. (b) The central cells of an ingrowing epithelial mass undergo degeneration, thereby creating a cystic cavity containing a mucoid material. Growths in which this condition predominates have been termed "gelatinous cysts." (c) The mucoid material may undergo a process of liquefaction and a serous cyst result. (d) Secondary cysts are formed from the walls of the primary cyst by the outgrowth of epithelial folds and follicles, in which the original processes of cyst formation are repeated.

As observed clinically, an epithelial cystoma may present one or all of the above described conditions. Conjunctival growths heretofore reported as epithelioma in children, gelatinous cysts, non-malignant cylindroma, the majority of serous cysts occurring on the ball and tarsus and some pterygium cysts were probably, in most instances, cases of epithelial cystoma.

Cysts of Krause's glands and lymphatic cysts should be carefully differentiated from epithelial cystoma.

Rabinowitsch (*Viestnik Ophth.*, Vol. 27, p. 343) describes four cases of *conjunctival cyst*. The first occurred in a boy aged 16 years. The cyst involved the entire lower cul-de-sac. It had existed for five years. In the second case the upper retrotarsal fold was the site—in an eye with trachoma of a girl aged 8 years. The third case was seen in a woman aged 50 years. The cyst involved the semilunar fold. In the fourth case the cyst developed in the scar resulting from the extirpation of a conjunctival sarcoma. The cysts were all similar histologically, having developed from Krause's glands.

From the study of a case in which the cyst developed in the bulbar conjunctiva at the seat of a trauma, Carlini (*Graefe's Arch. f. Ophth.*, Vol. 72, p. 288) concludes that such cysts may arise from direct implantation of epithelial elements which have been detached from and driven under the conjunctiva by the traumatism, or from direct proliferation of the conjunctival epithelium into the subepithelial tissue owing to an epithelial plug becoming independent of the surface epithelium, resulting in an isolated epithelial cluster from which the cyst develops.

Lindahl (*Mitt. aus dem Carol. Augenklin. d. Med.-Chir. Inst. z. Stockholm*, p. 69, 1910) strongly differentiates between true trau-

matic cyst and lymphatic cysts, cystoid cicatrices, blood cysts and sub-conjunctival cysticercus, all of which may follow injury. He reports a cyst of the lower conjunctival sac following enucleation of the eye performed fourteen months after iron splinter injury, in which iridocyclitis followed the magnet extraetion. The cyst was the size of a hazel-nut. Its origin was an epithelial thread from the enucleation scar.

Oliver (*Ophth. Record.*, p. 137, 1909) has seen bilateral lymphectasia of the unmixed type, in an aged male. They were supposed to have been congenital. Microscopic study demonstrated that the cysts were walled and contained lymphoid cells surrounded by a transparent lymph.

Menacho (*Tr. Eleventh Internat. Cong. Ophth.*) saw complete *lymphectasis of the conjunctiva* occurring in the course of pregnancy, and disappearing upon delivery; showing a reflex action between the uterus and the eye.

Gabrielides (*Arch. d'Ophth.*, p. 100, 1909) removed a benign *angio-epitheliomatous cyst of the conjunctiva* from a man aged 28 years. It involved the outer aspect of the globe, extending from the canthus almost to the limbus. There had been no recurrence. Histologically the surface was covered by conjunctiva, the epithelium of which had become cuticular. It contained 10 cyst cavities, the linings of which were composed of cells like those of the conjunctival epithelium. The interior of some of the cysts was empty; others contained more or less granular débris.

Villard (*Ann. d'Oculist.*, Vol. 142, p. 183) removed a large cyst of the conjunctiva of the upper cul-de-sac from a man aged 28 years. It had made its appearance about eight years before and at first grew slowly, but later very rapidly. It was covered by a thin fibrous membrane and lined by stratified pavement epithelium. The contents was nuclear and cellular débris.

Awerbach (*Klin. M. f. Aug.*, June, 1909) reports a case of *lymphatic cysts of both lower cul-de-sacs*, in a man aged 59 years, affected with trachoma. The cysts were lined with cylindrical cells similar to the endothelial lining of lymph vessels. The cells rested upon a basement membrane and in one place became continuous with the endothelium of a lymph vessel.

According to Cabannes (*Ann. d'Oculist.*, Aug., 1908) *lymphatic cysts of the conjunctiva* occur most frequently on the inner side of the bulbar conjunctiva, or in the internal part of the superior or inferior cul-de-sac; chronic inflammations seem to play a part in their etiology. They are freely movable and easily removed. Such a cyst is lined by

one layer of endothelium, and numerous smaller, embryonic cysts may be found in the connective tissue surrounding the larger one. The contained fluid is clear and yellowish. Its cytological examination shows a preponderance of lymphocytes. Glandular cysts are usually found in the cul-de-sac, and are the result of obstruction of the glands of Krause or of Henle; or from a conjunctival fold, probably as a result of some chronic inflammatory process. The epithelial lining of these cysts may be squamous or polymorphous, usually in two or more layers. Mucous cells are often found. The contained liquid is clear yellowish. Cysts by inclusion arise from wounds, a fragment of conjunctival epithelium, included in the deeper parts of the conjunctiva, undergoing a cystic evolution. The cyst is usually in the neighborhood of the limbus, and is movable upon the sclerotic. Its lining is pavement epithelium in one to three layers.

N. Scalinci (*Gaz. Internaz di Med.*, May 30, 1908) reports a subconjunctival cyst of the inferior cul-de-sac in an infant aged 13 months. The cyst measured two by one centimeters, and when excised, was found to have arisen from Krause's glands, by dilatation first of the excretory ducts and later of the acino-tubular glandular tissue itself.

Cosmettatos (*Klin. M. für Aug.*, Aug., 1908) records a case of *congenital cyst* of the conjunctiva, the size of a hazel-nut, springing from the upper fornix. Microscopical examination showed it to be lined with endothelial cells; it was therefore placed among the cystic lymphangiomas, which are congenital and due to a developmental disturbance of the lymph channels.

In a girl aged 9 years, Rolandi (*Ann. di Ott.*, Vol. 41, p. 741) observed a pear-shaped, light-yellow, translucent swelling, somewhat smaller than a pea, upon the upper conjunctiva of the globe and fornix one month after a trauma. The conjunctival cyst was found to be lined by reniform, partly cylindrical, partly multilayered pavement cells and partly of a single layer of epithelium and connective tissue. The reporter considers that it originated in a gland of Henle, and that the trauma was the occasion of its growth, the duct of the gland becoming closed by scar tissue.

The epithelial cyst described by Bistis (*Ophthalmology*, Vol. 8, p. 606) developed in the conjunctiva at the corneal limbus of a boy aged 11 years who had had spring catarrh for two years. The growth was the size of a pea, and contained a yellowish fluid. It was probably the result of infolding of the epithelium, with pseudoglandular formation and obstruction of the lumen.

A tumor of the limbal conjunctiva containing follicles and mucous cysts, and suggestive of a typical vernal conjunctivitis, has been

studied microscopically by Bartels (*Zeits. f. Aug.*, Sept., 1908) who has especially examined the so-called glands of Manz, and their relation to the formation of cysts. He regards these bodies as real glands, and thinks their connection with the cysts doubtful.

Garcia (*Rev. de Med. Y. Cirug. Pract.*, Vol. 78, p. 449); Cirincione (*Beiträge Zur. Aug.*, Vol. 55) and Colombo (*Clin. Ocul.*, Vol. 14, p. 1620) have also reported and described similar cysts.

Dermoid of the conjunctiva has three places of predilection, the corneo-scleral margin, the caruncle and the conjunctival fold of transition. It is a congenital defect. While usually single it may be multiple or bilateral. The most frequent site is the upper-outer quadrant of the globe, between the superior and external recti muscles. It is a flattened, elongated, at times lenticular, reddish-yellow growth, often covered with fine downy hair, that usually appears after puberty. Histologically, these tumors are closely related to skin. They contain connective tissue stroma, hair follicles, sebaceous sweat glands; and even cartilage has been observed. Quite a variety of theories have been offered concerning the origin of dermoids.

In explanation of the development of dermoids, Ryba offers the theory of failure of complete closure of the lids, with consequent cornification of the conjunctiva. Gallenga pointed out the fact that the semilunar fold covers the globe in fetal life, Remak suggests fetal invagination of the external blastoderm, Van Duyse, adhesion of the amnion to the surface of the eye ball. Whichever theory is correct, some dermal tissue must adhere to the surface of the eye ball. See under **Dermoids**; as well as p. 3014, Vol. IV of this *Encyclopedia*; and **Congenital anomalies**.

Although dermoids are classed as benign growths, yet there are reasons why they should be removed completely, to remove the irritation, due to the hair on the surface, for cosmetic purposes and for histological study, to be assured of a correct diagnosis.

Harbridge's (*Amer. Jour. of Ophth.*, Vol. 1, p. 419) experience illustrates the necessity of being prepared to do a more or less extensive dissection in the removal of these growths. In his case a mass occupied the inner upper aspect of the bulbar conjunctiva and appeared to be a small, superficial cyst. Immediately after attacking the growth he appreciated how completely he had miscalculated its extent. It was necessary to rotate the eye well down and out and carry his dissection well towards the apex of the orbit. Microscopic examination showed a dermoid cyst.

Mayou (*Roy. London Ophth. Hosp. Rep.*, Vol. 16) after pointing out that some authors doubt the existence of *implantation dermoids of the conjunctiva*, refers to the cases of Uthoff and of Collins, and then

describes one of his own, which had the appearance of a large phlyctenule on the outer part of the bulbar conjunctiva, and which followed an injury to this eye with a piece of wood. The growth was excised and submitted to microscopic examination. Within the cyst the splinter of wood was found surrounded by mononuclear and polynuclear cells of all types, and some giant cells. The epithelium lining the cyst was of the type found on the surface of the bulbar conjunctiva, and the epithelium had evidently been carried inward in front of the splinter and then grown around it. No process of epithelium could be found connecting the surface epithelium with that of the cyst.

A boy came to Harman (*Tr. Ophth. Soc. U. K.*, Vol. 26) to have a hair taken out of his eye. There had been no pain or redness. In the upper fornix of each eye was found an oval, fatty dermoid, measuring 10 by 3 mm. The right bore 5 pale hairs about 7 mm. long; the left one, a strong black hair, 8 mm. long, and 3 smaller, white ones. At the corneal margin of the right eye there was a circular, white dermoid 2.5 mm. in diameter, containing 2 colorless hairs 5 or 6 mm. long. These hairs had been in constant contact with the conjunctiva without causing irritation.

In Krailsheimer's (*Klin. M. für Aug.*, June, 1912) patient, a child aged 8 months, the dermoid was a vascular pterygium-like growth extending from the temporal side of the globe over the outer half of the cornea. It was composed of a connective tissue stroma, tubulo-acinous glands, a plate of hyalin cartilage, lymphoid cells, smooth and striped muscle, adipose tissue, blood and lymph vessels, and nerve endings.

Other cases have been reported by Axenfeld (*Deut. Med. Woch.*, Vol. 43, p. 1182); Stieren (*Tran. Amer. Ophth. Soc.*, 1905); Johnston (*Carolina Med. Jour.*, Sept., 1904) and Levitt (*N. Y. Med. Jour.*, July 8, 1908). Shikano (*Nippon. Gank. Zasshi.*, Sept., 1916) describes a highly pigmented dermoid occupying the exact center of the lower palpebral conjunctiva.

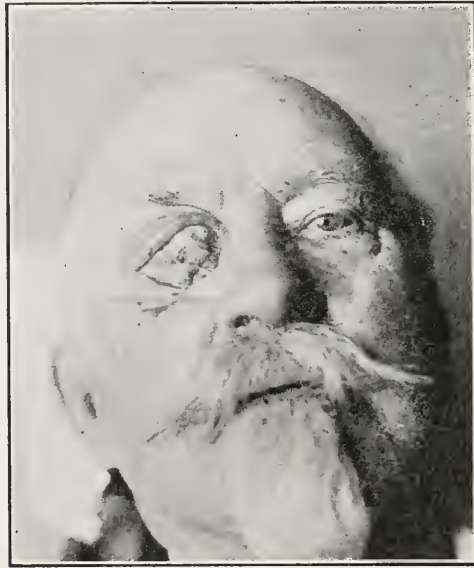
Endothelioma of the conjunctiva. These neoplasms are malignant tumors which, according to many authorities, spring from the endothelial lining of blood-vessels or lymphatics. When typical, they are fairly easy to identify. There are, however, benign growths which show a marked proliferation of endothelial cells, thus making it difficult to distinguish them from embryonic types. It is, perhaps, well to restrict the term to definitely distinguishable forms.

Aubineau (*Ann. d'Ocul.*, Feb., 1908), reports a primary tumor of the palpebral conjunctiva of the upper lid, which he classes as endothelioma. It was slowly progressive. Two years later a similar growth had appeared at the point of contact on the upper part of the cornea. Both were removed, and there had been no recurrence 18 months later.

TUMORS OF THE EYE

Epithelioma of the conjunctiva. The point of predilection for this type of malignant growth is transitional epithelium, e. g., the lid borders or the limbus; occasionally it is observed in other localities. Lagrange states that in such cases it is often on the nasal side.

The tumor begins as a small, rounded, papillary or wart-like hard mass. It may be slow in growth and painless; later, it increases greatly in size, forming a fungating mass that protrudes between the lids. In its advanced stages the surface ulcerates and bleeds easily. It is usually single, yet cases with multiple growths have been reported; contact cases have also been reported. Rarely glandular involvement,



Large Primary Epithelioma of the Ocular Conjunctiva. (Veasey.)

beginning with the preauricular gland, occurs. The growth is rather flatter than an epibulbar sarcoma and lacks its abrupt demarcation from the cornea. These tumors are more frequent in persons over 40 years of age, yet in this there is a wide variation..

Microscopic sections of epithelioma of the conjunctiva reveal the appearances of such growths in other parts of the body. There are down-growths into the stroma of columns of epithelium which divide and anastomose. Surrounding this is a moderate amount of fibrous tissue containing blood vessels. At some points the columns of cells break through the basement membrane; the cells in the columns proliferate, the central ones becoming compressed form nests or epithelial pearls; the peripheral, which are cubical, are the youngest cells. Upon

these are laid larger polygonal cells with interlacing processes—prickle cells. The nuclei of the cells vary greatly in size and in the amount of contained chromatin. At times it is difficult to differentiate between the proliferating endothelial cells surrounding the growth and the cells of the growth itself. Thus it is that many of these malignant growths show widely atypical modifications.

Recurrence after excision is common; they should, accordingly, be removed radically at the very earliest opportunity. Excision, radium, X-ray, desiccation and various chemical caustics have been used with varying success. If there is considerable involvement of the eye complete exenteration of the orbit may be indicated.

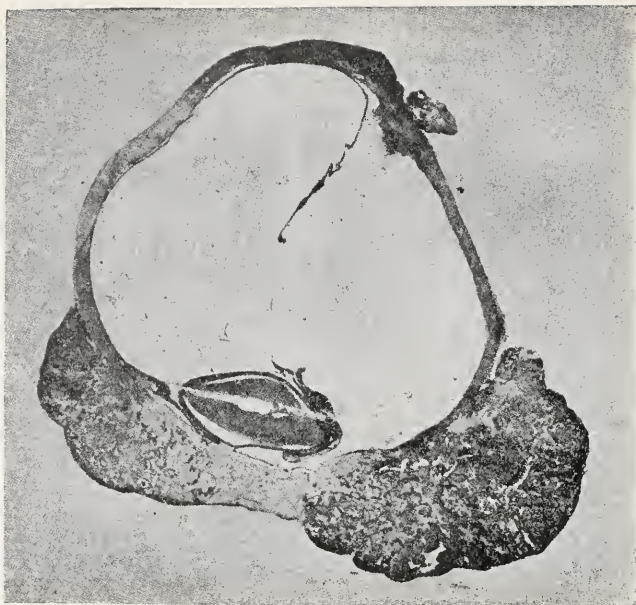
See, also, p. 3016, Vol. IV.

In the case of an extensive epibulbar growth reported by de Schweinitz and Shumway (*Tr. Amer. Ophth. Soc.*, Vol. 13, 1) the pathological examination confirmed the clinical diagnosis of *primary carcinoma of the conjunctiva*, beginning at the limbus. In 1912 the whole front of the eye was covered by a thick, reddish-yellow mass, closely resembling granulation tissue. Recurrence after enucleation rendered complete exenteration of the orbit necessary. In the enucleated globe the cornea was replaced, except as to a few of the posterior lamellæ, by a dense connective-tissue mass, into which the columns of epithelial cells extended from the temporal side. (See the figures.)

Giri (*Ophthalmoscope*, Vol. 11, p. 202) describes two cases of apparent contact inoculation of carcinoma of the eye. One was in a woman aged 75 years. The whole front of the eyeball was covered by a large carcinoma, which, however, did not involve the fornices. The lower lid showed irregular epithelial downgrowths proceeding from the lid margin towards the tarsus. The second example, in a man aged 58 years, which ultimately proved fatal by recurrence, appeared to have begun as carcinoma of the upper lid, which by inoculation had produced carcinoma of the margin of the lower lid and of the cornea.

Cosmettatos (*Ann. d'Ocul.*, Vol. 155, p. 32) describes a case of *recurrent epithelioma of the ocular conjunctiva*, where death occurred as the result of metastasis in the larynx, in spite of two operations. The first was treated by careful dissection of the tumor and extirpation along with the normal conjunctiva, followed by cauterization of the base. One year later the patient returned with a large tumor mass covering the eye. The globe was enucleated and as much of the conjunctiva as seemed to be affected also removed. The neoplasm proved to be an epithelioma that had invaded the corneal parenchyma and even the canal of Schlemm.

A case of *epithelioma of the ocular conjunctiva* of unusual size is reported by Jennings (*Ann. of Ophth.*, Apr., 1906). It occurred in



Carcinoma of the Conjunctiva. Section of eyeball showing position of epibulbar growth. (de Schweinitz.)



Carcinoma of the Conjunctiva. Primary epibulbar carcinoma; microscopic appearances. (de Schweinitz.)

a man otherwise healthy, at the age of 71; was four years in developing and was not painful. Size, horizontally, 4 inches; vertically, $3\frac{1}{4}$ inches, and it protruded 3 inches. The tumor was lobulated, of a reddish-cream color, covered with scabs; it bled easily and had a bad odor. It was found to be attached to the palpebral as well as the ocular conjunctiva. Its complete extirpation demanded the exenteration of the orbital contents together with the eyelids. The gaping wound that followed the operation was packed with gauze and covered by sliding grafts from the brow and cheek. Microscopic examination showed the growth to be an epithelioma of the ocular conjunctiva, with infiltration of the cornea, but not involving the other structures of the eyeball.

Crisp (*Tr. Amer. Acad. Ophth. and Oto-Laryn.*, 1916) believes that primary epitheliomata of the conjunctiva are not of extreme rarity. A peculiar feature of these tumors is that they may exist and develop over long periods of time without involving vital structures. The sclerocorneal limbus is, perhaps, the most frequent site. A few cases described have developed on the base of an old pterygium. The case reported was in this position. It measured 4x5x2 mm. No recurrence was observed four months after removal. Finnoff made the microscopic diagnosis of epithelioma.

Veasey (*Tr. Pac. Coast Oto-Ophth. Soc.*, 1919) reports a most unusual *primary epithelioma of the bulbar conjunctiva*, larger than a good-sized English walnut. A male, aged 56 years, gave a history of the presence of a small, reddish spot since childhood. This growth began rapidly to increase in size three years previous to observation. The fungating neoplasm measured 3 cm. in diameter. Sections mainly appeared papillomatous. There were no prickle cells or pearly bodies, yet about the borders occurred distinct penetrating cords and groups of cell masses, islets, and lines of epithelium, indicating essentially a malignant growth.

Chevalier (*Ann. d'Ocul.*, Vol. 143, p. 406) reports a case of epithelioma of the conjunctiva which was exceptional in that it was located in the palpebral portion of the membrane. In Wecker's (*Bull. de la Soc. Belge d'Opht.*, No. 28, p. 33) case an *epithelioma at the internal canthus*, the growth had spread to the semilunar fold and to the orbit. An extensive operation, including exenteration of the ethmoids, resulted in a cure.

The bibliography of this tumor (*including carcinoma*) is extensive; among the titles are: Calindez (*Rev. Ibero-Ann. de Cien. Med.*, Vol. 33, 186), who describes epitheliomata of the conjunctiva; Fagin (*So. Med. Jour.*, Vol. 8) described an epithelioma following a pterygium; Block (*Cor. Bl. f. Schwiz. Aertze*, Vol. 46, p. 277) advises

treatment by carbon dioxide; Delord and Revel (*Ann. d'Ocul.*, Vol. 142, p. 432); Barmettler (*Gior. Internaz delle Scienze Mediche*, Feb., 1908); Jeung (*Klin. M. für Aug.*, Jan., 1908); Puccioni (*Zeits. f. Aug.*, Jan., 1908); Fage (*La Clin. Ophtalmol.*, June, 1903); Lagrange (*Tumeurs de l'Oeil*, Vol. 1); Noyes (*Tr. Amer. Ophth. Soc.*, 1882); Oliver (*Ann. of Ophth.*, Vol. 26, 1897); Reis (*Klin. M. für Aug.*, Vol. 41); Natanson, A. V. (*Vestnik Oftalmologii*, Moskow, Vol. 25, p. 125); G. Addario (*Il. Progresso Oftalmologico*, Pal., 1909, Vol. 5, pp. 32-46); Rollet et Grandclement (*Rev. Générale d'ophtalmologie*, 1909, Vol. 28, p. 272); Odinzew (*Vestnik Oftalmologii*, Moskow, 1909, Vol. 26, p. 422); E. de Souza Campos (*Clinique Ophtalmologique*, 1909, Vol.



Epithelioma of the Conjunctiva. (Veasey.)

15, p. 486-590); W. H. Wilder (*Ophthalmic Rec.*, 1909, Vol. 18, p. 120); Montinho, M. (*Recueil d'Ophtalm.*, 1910, Vol. 32, p. 156); Wolfrum (*Berichte über die Versammlungen der Ophthalmologischen Gessellschaft*, 1911, Vol. 37, p. 393) and Danis (*La Clinique*, Brussels, 1911, Vol. 25, p. 614).

Fibroma of the conjunctiva. These neoplasms really belong to the group of polypoid growths. They are observed on the palpebral conjunctiva and occasionally spring from the fornix, but are of greater frequency in the neighborhood of the caruncle. In contradistinction to papillomata, they have a smooth surface. The hard fibroma consists of closely packed bundles of fibrous tissue with few blood vessels. They grow slowly, do not recur readily and usually occur on the palpebral conjunctiva, near the caruncle. The soft fibromata grow rapidly and bleed easily. They are composed of bundles of edematous

fibrous tissue, blood vessels, connective tissue cells and lymphocytes. They are frequently attached by a pedicle to the fornix. Exsection and cauterization of the base is the proper method of treatment. See, also, p. 5186, Vol. VII of this *Encyclopedia*.

Galezowski (*Soc. d'Ophth. de Paris*, Feb. and June, 1908) reports a tumor, 2 cm. in diameter, rather loosely attached at the upper cul-de-sac, as one of *fibro-myxoma*, the histologic examination showing fibrous and so-called mucous tissue, an association frequently seen in the nose, but rare in the conjunctiva.

Denzer (*Zeitschrift f. Aug.*, 34, p. 311) observed a *hard fibroma of the conjunctiva*. An otherwise healthy man, aged 20, presented a hard, bluish-red tumor the size of a cherry in the subconjunctival tissue of the lower segment of his right eyeball. The conjunctiva was injected and freely movable over the tumor; the tumor itself was easily movable upon the sclera, with which it was connected by loose connective tissue. It had a broad base and was readily enucleated. At some points the base was attached to the sclera by tough fibrous strands of the aspect of tendinous or scleral fibers, which had to be cut with scissors. The conjunctival wound was closed by three sutures, and healed in a few days.

Histologically, the tumor had the structure of a hard fibroma. It consisted of interlaced fibrillæ, blood vessels, and two kinds of cells—round cells of equal size with round nuclei, scattered all over, and spindle cells with long processes and several nuclei between the fibrillæ; but the proportion of cells to fibrillæ was small. There were also larger spaces, empty or filled with red blood corpuscles; the walls of the latter consisted of a single layer of endothelium. There were no elastic fibers.

Denzer remarks that the literature contains only eight cases, all in men between the ages of 18 to 25, excepting one, aged 58. In all instances the tumor was pedunculated. In this respect the writer's case was different; also because it had a tough capsule of connective tissue, while the others showed a lining of proliferated conjunctiva or flat epithelial cells.

Reis (*Arch. of Aug.*, Vol. 64, p. 141) saw, springing from the conjunctiva to the temporal side of the cornea, a *pediculated fibroma* the size of a hazelnut. The pedicle was short and spread out over part of the cornea. The growth had been first noticed when the patient was 8 years of age and had slowly increased in size in its fourteen years' growth. Microscopically, it was a hard fibroma with a tendency to hyaline metamorphosis of the parenchyma.

That subconjunctival lipoma, thus diagnosed from the clinical standpoint, is not always what it appears to be, is evident from an

investigation by Gonin (*Arch. of Ophth.*, March, 1904), who found that a growth of this character, exposed by operation, had its origin in the external rectus muscle, and was resting on its tendon. Microscopical examination of the tumor revealed an *angio-fibroma* with hyaline degeneration.

Other papers are by Scott (*Arch. of Ophth.*, July, 1904), who reported a fibromyoma of the bulbar conjunctiva; Leoz Ortin (*Arch. de Oft.*, Vol. 14, p. 39), who described multiple fibroma of the conjunctiva; Yamaguchi (*Klin. M. für Aug.*, July, 1906) and Trousseau (*Ann. d'Oculist.*, March, 1906).

Granuloma of the conjunctiva develops at the site of an injury, such as follows operative procedures for strabismus; and resembles a



Granuloma of the Conjunctiva. Moderately severe case showing flat or nodular masses between eye and lids. (McAll.)

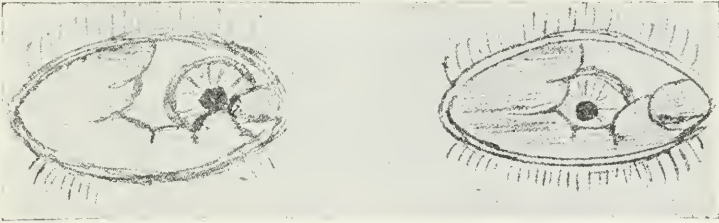
polypus. The growth is not covered by conjunctiva, and is formed of true granulation tissue. The tears are frequently blood-stained, due to the friability of the small blood vessels. It should be clipped off and the base cauterized. See p. 5630, Vol. VII.

Strupow (*Klin. M. für Aug.*, Nov., 1908, p. 645) records a granuloma situated in the upper retro-tarsal fold.

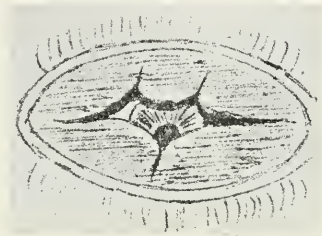
Following a hordeolum, Kraus (*Berlin. Kl. Woch.*, Vol. 51, p. 1045) observed a granulation tumor of the tarsal conjunctiva. It was about one-half the size of a hazel-nut, and lay between the bulb and the lid. Microscopical examination showed much granulation tissue, with many vessels and a large number of giant cells; multiple lymphoid nodules were present.

In Worth's (*Tr. Ophth. Soc. U. K.*, Vol. 30, p. 152) case of sup-

posed granuloma of the conjunctiva, the growth, which was pedunculated, was at the sclero-corneal margin; and consisted of a pad of conjunctiva with vessels radiating from a common center.



Drawings show how the eyeball could move behind the growths.



Drawing of a More Advanced Case, showing how the tumor masses gradually spread in front of the eyeball.



An Advanced Case Involving all the Eyelids; duration, left eye 6 years, right eye 7 years. Dark central area in palpebral aperture leads down to cornea.

McAll (*Brit. Jour. of Ophth.*, Jan., 1920) states that there are seen from time to time in Central China patients whose eyesight is obstructed, entirely or partly, by the formation of tumor-like masses which grow between the eyeball and the lid. There is no conjunctivitis

or other acute inflammation. The growths are painless; they do not ulcerate on the surface or break down in the center, but remain firm throughout. They gradually involve the eyelids, producing great thickening, which finally causes the mechanical occlusion of the palpebral aperture.

The writer has seen about a dozen cases of this rare form of *subconjunctival granuloma*. The patients varied in age from 15 to 40 years, the majority being men. One or both eyes may be involved; the duration of the case ranges between one and a half and nine years. Sections of the tumor show that the bulk of the growth is composed of round cells (lymphocytes) which infiltrate the normal tissue. The periphery of the growth is vascular; the cells in the center show no sign of breaking down.

Hæmangioma. See *Angioma of the conjunctiva* herein.

Lipoma of the conjunctiva. A subconjunctival growth of a yellowish color, movable upon the eye ball and usually single. It is congenital, and frequently remains quiescent until puberty, when it begins to grow, ultimately attaining a diameter of one or two centimeters. It is often located in the region of the lachrymal gland. Lipomata do not recur after removal. See, also, p. 7495, Vol. X of this *Encyclopedia*.

Ahlstrom (*Beit. zur Aug.*, 61, p. 1) reports two cases of *subconjunctival lipoma*, in one of which bone was found, while the other was composed purely of fatty tissue. In the latter case serial sections of the entire growth were made, but no epidermal structures could be found. He thinks that subconjunctival lipomas do not all have the same origin, and that the cases already reported prove definitely that it is possible for them to consist of pure fatty tissue, despite the views of others to the contrary.

Vossius (*Trans. Thirty-ninth Ophth. Congress*) reported that in a young girl bilateral symmetrical lipomata formed near the inner canthus on the upper lid. These displaced the lachrymal puncta and drew up the caruncle.

Rochat (*Tydschr v. Gen.*, Jan. 26, 1907) discusses very fully, lipomata and dermo-lipomata of the conjunctiva. Other papers are by: Lafon (*Jour. de Méd. de Bordeaux*, Vol. 34, p. 715); Dupont (*L'opht. Prov.*, No. 7); Pes (*Zeits. f. Aug.*, Jan., 1908) describes a case of symmetrical subconjunctival lipomata; Maze (*Lyons Thesis*, 1910).

Lipo-dermoid of the conjunctiva appears as a pear-shaped, yellowish growth usually near the limbus or at the upper-outer aspect of the globe. According to Lagrange it is generally adherent to the conjunctiva, being a growth from that tissue. This growth is congenital

and frequently does not show marked development until puberty. It is composed of fatty-fibrous material and dermal tissue with a few hair follicles and glandular tissue. Complete removal is not followed by recurrence.

An exceptional case of *multiple lipodermoids* is reported by Stoll (*Amer. Jour. Ophth.*, Vol. 30, p. 1). The patient was a woman aged 33 years. There were two growths in the right and four in the left eye, to the outer side of the globe and in the upper and lower fornices. The patient presented several other anomalies, including asymmetry of the face and deflection of the nose; coloboma and ptosis of one upper lid; congenital corneal opacity of the left eye; posterior polar and posterior punctate cataract and remains of the hyaloid artery in the left eye; hemeralopia, astigmatism, and some degree of amblyopia; and polyotic growths in front of the left ear. Her parents were children of two sisters; and one of her two brothers showed some anomalous conditions.

Lamb and Hardy (*Amer. Jour. Ophth.*, Nov., 1916) contribute a history of lipodermoid of the bulbar conjunctiva with accompanying congenital defects. A boy, aged 10 years, presented a large, soft, reddish growth, extending from within the corneal limbus to the outer angle of the eyelids, and downward beyond the equator of the globe. The overlying conjunctiva was adherent. The accompanying congenital defects were a coloboma of the iris, remnants of the pupillary membrane, a bony defect in the left temporal region, undescended testicle, moderate hypospadias and two large fat-pads above the symphysis pubis.

Sections of the growth showed loose fibrous tissue, vascular structure, fat tissue but no cilia or hair follicles, which is in accordance with the expressions of several writers that hair does not develop on these growths before puberty.

Hirsch (*Klin. M. für Aug.*, July, 1912) reports three cases of *multiple lipodermoids*, two of the patients being affected in both eyes. Only one of the growths had the location commonly described as typical, namely at the limbus between the superior and external recti. The situation of the rest of the growths was such as to lead the author to set up "a fourth type of lipodermoids, located in the region of the lateral commisure." Other congenital malformations of some kind were present in each one of these cases.

Wagenmann (Graefe's *Arch. f. Ophth.*, Vol. 74, p. 511), reports a case of multiple lipodermoids in one eye. One of the growths was at the lower-inner sclero-corneal border, the other in the conjunctiva between the superior and internal recti. The conjunctival growth

contained the constituents of the cuticle, including a number of unusually long thick hairs, sebaceous and sweat glands and papillæ.

Mueller (*Arch. of Ophth.*, Vol. 45, p. 505) removed bilateral symmetrical dermoids at the inner canthi. He believes his case to be the second of the kind on record. The patient was a girl aged 17 years. The caruncles were displaced equally, the upper punctum was absent on one side, and led into a short cul-de-sac on the other.

Fehr (*Berlin Ophth. Gesellsch.*, May, 1908) demonstrated a congenital lipo-dermoid, containing hair and glands, in the conjunctiva of a three months' infant; Germann (*St. Petersburg. Ophth. Soc.*, Feb., 1908) reported a case of fibro-lipoma of the limbus; Natanson's (*Klin. Mon. f. Aug.*, June, 1909) case was one of lipodermoid of both conjunctivæ. There was also a lipoma in the scapular region. The patient was a man aged 60 years.

In addition to these authorities others have written on this subject as follows:

Miller (*Zeit. f. Aug.*, Vol. 34, p. 157) reports a case of bilateral, symmetric lipodermoid; Johnson (*Ophth. Rec.*, May, 1904); Hummelshcim (*Arch. f. Aug.*, Vol. 62, Ht. 1).

Lymphangiectases. (See under *Cysts of the conjunctiva.*) These are small dilatations of the lymphatics of the conjunctiva. They are of pin-head size and are arranged in rows. See, also, p. 7558, Vol. X of this *Encyclopedia*.

Lymphangioma. Tumors of this description are formed by large cavernous dilatations of the lymphatics. They may be single but usually they form a series of cavities separated by thin fibrous walls lined with endothelium. They may assume a considerable size; Parsons examined one in which the whole conjunctival sac was involved. See p. 7558, Vol. X of this *Encyclopedia*.

Erb (*Zeit. f. Aug.*, Vol. 29, p. 120) furnished the history of a case of lymphangioma of the conjunctiva in a boy aged 10 years, who developed, soon after birth, a flat, soft tumor at the right eyebrow, which gradually grew and spread over the sclera in the form of a gelatinous swelling. After a blow on the eye two weeks previously the white swelling suddenly became dark-red. It was movable with the conjunctiva. For exact diagnosis, a piece was examined at the pathological institute at Zurich, and found to be part of a hemato-lymphangioma. The epithelium of the conjunctiva was intact, the subconjunctival tissue was thickened, and contained numerous cavities of different sizes, which were partly empty, partly filled with a homogeneous mass, coagulated lymph; some with blood. The cavities were lined with endothelium. The septa were composed of fibers of nu-

clear connective tissue in which nodules of lymphatic tissue were mingled, partly with fresh inflammatory infiltrations. Since, on account of its extent, total extirpation of the tumor was out of the question, it was reduced by electrolysis. When, after some time, the patient returned, the eye was white, and the whole ocular conjunctiva showed a markedly pale, chemotic swelling. V with — cyl. 4.00 at $90^\circ = \frac{5}{15}$. Dionin produced an enormous swelling of the conjunctiva, which subsided after five days.

With regard to the etiology, Erb adopts the explanation of Ribbert, who assumes processes of proliferation of connective tissue and lymphatic spaces lined with epithelium; starting from a tissue which was separated during intra- or extrauterine life.

Lymphoma of the conjunctiva. The conjunctiva and lachrymal gland being the only ocular structures containing lymphoid tissue they are, consequently, the only structures in which primary growths of this type can originate. The most frequent site is the plica, or fornix; rarely at the limbus. They have much the appearance of large follicles, are painless and usually are observed only during a routine examination for some slight conjunctival disturbance. Histologically, they are not a clearly-defined growth but very likely represent different pathological conditions. They present many of the characteristics of lymphatic glands; a fine fibrous stroma with endothelial cells, plasma cells and mononuclear round cells; the blood vessels are few and small. The condition occurs in leukemia, and is also referred to by some authors in describing Parinaud's conjunctivitis. It is a benign growth, but in rare instances malignancy has been observed. See, also, p. 7562, Vol. X of this *Encyclopedia*.

According to Werner (*Tr. Ophth. Soc. U. K.*, Vol. 35, p. 59) primary lymphomatous disease of the conjunctiva has been described as *pseudo-trachoma*, and is characterized by large follicles in the retrotarsal folds and palpebral conjunctiva, also affecting the plica or its neighborhood. It may furthermore occur as a diffuse lymphoid infiltration of the conjunctiva. In one such case examined by Morax the microscope revealed pure lymphomatous infiltration, exactly as it was present in Werner's patient. Werner points out that Raehlmann, Kubli and others hold the view that amyloid degeneration of the conjunctiva is always preceded by a proliferation of adenoid tissue.

Demaria's (*Bol. Soc. de Oft. de Buenos Aires*, Vol. 3, p. 44) patient, a woman aged 30 years, had symmetrical lymphomata of both upper conjunctivas. In each superior cul-de-sac there was a grayish-red mass. One year after removal the patient returned with similar

growths, but larger, involving the inferior cul-de-sac. Further operation was refused.

Cosmettatos's (*Arch. of Aug.*, Vol. 67, p. 391) patient with lymphoma was aged 18 years. The growth was situated in the bulbar conjunctiva, extending inwards from the sclero-corneal margin. It was of a pale-red color and of smooth surface. The entire tumor was made up of lymphoid tissue which in places formed masses, while elsewhere it was diffused. There were no changes in the white blood cells and no enlargements of the lymphatics.

Morax and Polack's (*Soc. d'Ophth. de Paris*, July, 1908) case was one of mononuclear, subconjunctival infiltration of the semilunar fold, not connected with any chronic inflammation—a lymphoma and not a dermo-epithelioma.

Gilbert (*Zeit. f. Aug.*, Vol. 38, p. 152) describes a syphilitic lymphoma of the conjunctiva; Chevalier (*Ann. d'Ocul.*, Vol. 151, p. 467) reports a bilateral lympho-adenoma of the conjunctiva; Henderson (*Tr. Ophth. Soc. U. K.*, Vol. 26) writes on conjunctival lympho-sarcoma. Other papers are by Rscanizyn (*Klin. M. f. Aug.*, Jan., 1908) and Roy (*Ann. d'Ocul.*, Nov., 1908).

Myxoma of the conjunctiva is rarely reported. Mancione (*Arch. di Ott.*, Vol. 21, p. 300) observed a rare subconjunctival tumor of about six years' duration. It protruded between the lids, was a rose color, smooth and freely movable beneath the conjunctiva. After excision, it proved to be composed entirely of myxomatous tissue. See p. 8280, Vol. XI of this *Encyclopedia*.

Nævus of the conjunctiva is a congenital growth or, at least in its rudimentary form, is present before birth. The conjunctiva being a modified form of skin is sometimes subject to this new-growth. Clinically there are two forms, namely, *pigmented* and *non-pigmented*. The pigmented is of more frequent occurrence, and may develop anywhere in the conjunctiva. The non-pigmented usually occurs on the bulbar conjunctiva near the limbus. It is more frequently observed in young people. These growths present a flat, smooth, yellowish-red elevation; the pigmented variety being more brownish and of a less smooth surface. Both types may develop malignancy after long intervals of quiescence; the pigmented class being especially prone to sarcomatous changes. It is, therefore, highly important that energetic measures be adopted for complete eradication of these growths. Histologically, it may be seen that the epithelium sends long processes into the stroma of the conjunctiva. Between these processes, cells, known as nævus cells, lie heaped together. When the nævus is pigmented the brown pigment granules lie, in part, between the nævus

cells in the spindle-shaped and stellate connective tissue cells, and vascular tissue. They are referred to as chromatophores.

The origin of the naevus cells is debatable; some authorities believe they come from epithelial tissue, others from connective tissue. Cystic development is frequently observed in these tumors; some authors believe they are formed by pushing apart of the naevus cells; others regard them as due to cystic degeneration.

Treatment consists of thorough excision, cautery, electrolysis, or desiccation. See **Conjunctiva, Nævi of the**; also **Nævus, Ocular**, p. 8283, Vol. XI of this *Encyclopedia*.

Wolfrum (Graefe's *Arch. für Ophth.*, Vol. 71, p. 195) believes that areas of pigmentation in the conjunctiva are in the majority of instances nævi inasmuch as there exist in these tumors not only epithelial pigmentation but more or less marked accumulation of pigmented cells in the subconjunctival tissue. Their epithelial origin can be traced in every instance. The histolytic and migratory activity of these cells is in common with that of tumor, and is to be considered a factor in metamorphosis.

A case of non-pigmented naevus of the caruncle is reported by Bergmeister (*Zeit. f. Aug.*, Vol. 25, p. 495). There were in places cell bridges between the epithelium and the clusters of naevus cells. In places where groups of naevus cells were in contact with the epithelium, the basal cells were lacking, and in their stead was homogeneous tissue containing small spaces and isolated nuclei. The writer does not agree with Wolfrum as to the epithelial origin of naevus cells.

Two cases of *navus of the bulbar conjunctiva* are described by Alt (*Amer. Jour. of Ophth.*, Vol. 29, p. 294), who regards the histologic details as supporting Wolfrum's contention that such growths are of epithelial origin. This view is also supported by Casolino (*Arch. di Ott.*, Vol. 21, p. 90) who reports a case of the same kind, in which the pigmental cells showed a tendency to displace the underlying connective tissue by simple compression.

Uno examined microscopically an unpigmented nævus of the bulbar conjunctiva which had twice recurred after excision and concludes that the cells of these growths are nothing more than basal cells which have proliferated through division of the nucleus.

Foster (*Klin. Mon. f. Aug.*, June, 1904) wrote on unpigmented nævus of the conjunctiva. He describes a case of this character in which a considerable portion of the growth was composed of invaginations of the surface epithelium and the formation of cysts within these epithelial processes. Clinically the growth presented itself in

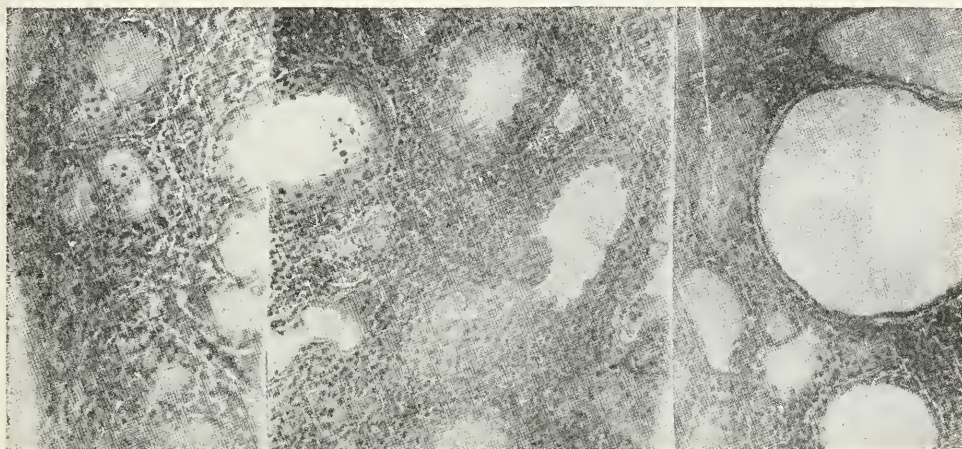
the form of a flat, reddish-yellow deposit on the conjunctiva near the outer border of the cornea. It had been present from birth. Foster is inclined to consider the cases described under the name "dermo-epithelioma" and "benign cystic epithelioma" closely allied to if not identical with naevi, and thinks that in the structure of the naevus not only epithelial invaginations occur, but that mesodermal elements, especially endothelial, are also present and form the naevus cell nests.

Ronne (*Klin. M. f. Aug.*, April, 1909) observed two instances of *non-pigmented naevus of the conjunctiva*, which presented itself in one case as a bright, yellowish-brown, semi-transparent, sharply-defined thickening of the conjunctiva extending from the caruncle to the limbus. In the other instance it appeared as a flat, reddish thickening of the conjunctiva involving the limbus and conjunctiva for a distance of 0.5 cm. therefrom. Both patients were females. Histologically the tissue contained two kinds of cells. The epithelial cells were arranged in "pegs" or tracts; or they formed larger and smaller cysts with walls of single or multiple cell layers. There was no tendency to malignant proliferation of the epithelial pegs, although they resembled, as always in naevi, epithelioma. In several places there were tongue-like communications between the epithelium of the cysts and the superficial epithelium. Besides these cells there were large accumulations of naevus cells, smaller and darker-stained, but with little protoplasm—thus resembling somewhat sarcoma—but showing no malignancy. There was no pigment, but in one place the spindle-shaped protoplasm had a yellowish-brown border, made up of fine points. There were also mast and goblet cells. One of the cases was successfully treated by the use of the galvanocautery.

Capron's (*Tr. Amer. Ophth. Soc.*, Vol. 14, p. 322) case of *multiple melanotic naevi of the conjunctiva*, with invasion of the corneal limbus, had been preceded for years by peculiar pigment deposits in the palpebral and scleral conjunctiva. A tumor developed at the site of one of these spots in the lower lid. Examination of the removed mass showed it to be a melano-sarcoma. Two years later recurrence in the cornea developed, necessitating enucleation.

The case reported by Von Hoor (*Klin. M. für Aug.*, May, 1912) is a tragic illustration of the danger which lurks in the apparently innocent pigmented mole or naevus. A woman brought her 15 year-old daughter for removal of a small congenital "wart" at the corneal limbus, which had been thought to increase in size during the last few weeks. On marked adduction of the eye a further small growth was visible, which neither mother nor daughter had previously discovered.

Arguing that this second spot must represent metastasis from the first, Von Hoor urged enucleation, which was refused. A little later Fuchs removed the limbal growth, which showed a limited area of beginning melanosis. There was no recurrence in the eye; but ten weeks later an enlarged and sarcomatous preauricular gland was removed from the corresponding side. It was soon necessary to remove similar metastases from the neck and submaxillary region. Death occurred eight months after the patient's first visit to Von Hoor. The case demonstrates that metastasis from a "birth mark" may occur at a stage in the development of the original growth which barely reveals histologic signs of sarcomatous degeneration. In this case the



Degenerated Epithelial Nævus of the Conjunctiva. (Alt.)

early involvement of the preauricular gland renders it certain that neither enucleation of the eye nor exenteration of the orbit would have prevented glandular metastases. Von Hoor resolved urgently to advise removal of every pigmented mole as soon as brought to his notice.

A *conjunctival pigmented mole* of rapid growth in a man aged 35 years was observed by Moore (*Tr. Ophth. Soc. U. K.*, Vol. 35, p. 226). The growth had been present for two years. The greater part was pigmented, but a more fleshy, unpigmented part had slightly overgrown the cornea.

Alt (*Amer. J. of Ophth.*, Vol. 33, p. 289) examined a small growth of the bulbar conjunctiva removed by Hardy from a patient aged 19 years. The mass was of one year's duration, sharply-limited, benign-looking and non-pigmented. Microscopic examination made it difficult to classify the tumor. In the main it was epithelial; the dis-

lodged epithelial cells appeared to form thin, solid, cell-cylinders, yet the cells forming these cylinders in many places very quickly had undergone a regressive metamorphosis which seemed to start more or less centrally. The flat cells showing large oval nuclei which were at first closely packed seemed to lose their sharp outlines; the central nuclei no longer took the stain, while those readily stained formed more regular peripheral rows in the transverse sections of these cylinders. The center changed into a transparent, more or less amorphous, mass in which here and there a nucleus was still to be seen. The large amount of infiltration rendered it suspicious of malignancy. After careful study Alt was inclined to look on this tumor as a degenerated epithelial nœvus.

The *conjunctival* growth described in 1884 by Parinaud under the name of *dermo-epithelioma*, consisting of an epithelial tumor penetrated by processes of connective tissue containing numerous vessels, has generally been regarded as benign. The case reported by Chailous (*Soc. Fr. d'Oph.*, 1911), however, suggests that such growths may pursue a malignant course. The patient had on the bulbar conjunctiva a flat growth resembling a pterygium, which was stated to have developed as the result of an injury received forty years earlier. The patient was then aged 46 years. During the intervening period very little enlargement had occurred. The inner third of the bulbar aspect of the lower lid, in correspondence with the tumor on the eyeball, was occupied by an ulcerated neoplasm. Both growths were removed. That from the globe consisted of epithelial masses (some solid, some riddled with cavities) enclosed in an abundant framework of connective tissue. The lid tumor was a glandular epithelioma mainly developed at the expense of the Meibomian glands. The author argues that this case shows that, after years of inactivity, these dermo-epithelial growths may inoculate their vicinity as the result of friction. In spite of apparent benignity, their future is uncertain, and thorough removal is indicated.

Vollaro (*Ann. d'Ocul.*, Vol. 144, p. 276) describes benign tumors of the conjunctiva of the type of the dermo-epitheliomata of Parinaud as composed of two different types of elements, both derived from the epithelium of the bulbar conjunctiva. The cells of the primary type preserve distinctly the character of embryonal epithelium. They form the epithelial globules and, posteriorly, the cyst cavity. The second type is much more numerous and represents the mass of the neoplasms and, morphologically, differs very little from mesodermal elements. From the clinical and histological characters it would seem

probable that non-pigmented cysts have their origin in the epithelium of cutaneous naevi.

Osteomata of the conjunctiva are generally believed to be rare, yet Parsons has examined three such growths from different patients. Von Graefe, Snell, Hartridge and many others have reported cases. Parsons (*Pathology of the Eye*, Vol. 1, p. 137) describes these tumors as congenital growths occurring between the superior and external recti muscles. They are classified as *teratomata* and are probably examples of atavism. The bone is irregularly developed, the laminae running in all directions. The tumor is usually convex on the upper and flattened on the deep surface. They do not recur after removal.

See p. 3048, Vol. IV; as well as p. 9198, Vol. XII of this *Encyclopedia*.

Dugardin (*Ann. d'Oculist.*, Vol. 144, p. 418) reports a case of *subconjunctival osteoma* in a child aged 8 years. The growth had been present since birth and had gradually increased in size. It formed a small, round tumor at the outer angle of the eye, beneath the conjunctiva. On palpation it was hard and movable, and looked precisely like a tooth. This tumor is always congenital, and is due to displacement of embryonal dental cells into the conjunctiva, where they develop as bone.

Schreiber (Graefe's *Arch. f. Ophth.*, Vol. 84, p. 420) describes a *teratoid osteoma of the conjunctiva*, which had developed between the insertions of the superior and external recti. The patient was a girl aged 12 years. The growth, which had been present from birth, measured 14 mm. in diameter. It lacked most of the characteristics of lipodermoids, and consisted in large part of bone enclosed in dense periosteal connective tissue.

Papillomata of the conjunctiva are observed most commonly on the caruncle. They have also been observed in the fornices and near the limbus. This growth has a characteristic cauliflower surface, the result of a papillary proliferation. They occur, single or multiple, at all ages and are liable to recur following removal. Some have been known to undergo malignant changes. They consist of a central core, fibrous and vascular tissue.

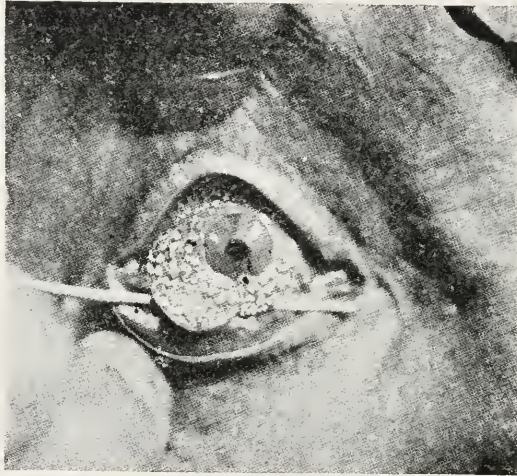
Radical excision and cauterization or desiccation is always indicated.

See p. 3048, Vol. IV and p. 9241, Vol. XII of this *Encyclopedia*.

In Coover's (*Ophth. Rec.*, Oct., 1903) case the growth started from the temporal margin of the cornea 8 months after the removal of a supposed pterygium from that situation. It had entirely circled the

cornea, except 3 mm. of the upper nasal margin, and was rapidly extending upon the corneal surface. Johnston (*Ophth. Rec.*, May, 1904) also reports a case, originating in the scar of a pterygium, that had been twice removed from the usual situation at the nasal margin of the cornea; and another case also beginning at the nasal margin. (See the illustration.)

Krauss's (*Ann. of Ophth.*, Apr., 1911) patient presented a papilloma of the margin of the fornix of such an extraordinary size that it protruded from between the lids. It had been present, as a small, sand-like growth, for fifteen years. Within a few weeks, before coming



Papilloma of the Cornea. (Coover.)

under observation, it had increased to its present dimensions. There was no evidence of a recurrence after its thorough excision.

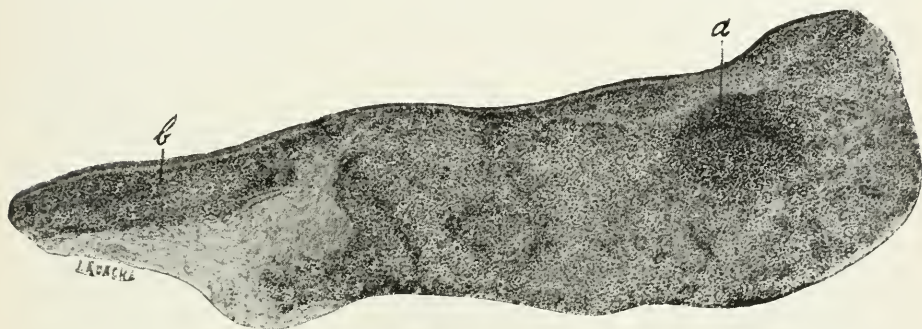
Birch-Hirschfeld (*Zeit. f. Aug.*, Vol. 34, p. 291) observed a papilloma of the conjunctiva and cornea, with a contact tumor of the lids. The patient, a man aged 29 years, had been treated for trachoma. A triangular, flat, red tumor, was situated at the outer edge of the cornea. From it were numerous projections of small isolated masses into the upper part of the bulbar conjunctiva; and one at the lower punctum. An excised portion showed the structure of a papilloma. The tumor was excised and the spot cauterized; when it healed completely.

Faith (*Ophth. Rec.*, May, 1908) reported a case of papilloma of the conjunctiva in a man aged 28 years, who had been operated upon a number of times. After four months' treatment with the X-ray the growth disappeared, and there was no recurrence in three years.

In Rutschmann's (*Klin. M. f. Aug.*, Dec., 1911) case of papilloma the epithelium and connective tissue was sharply delimited from the rest of the growth led to its being diagnosed histologically as benign. Yet, in spite of careful extirpation, there were several recurrences. Gagarin (*Vestnik. Ophth.*, Vol. 26, p. 131) removed from the conjunctiva of a boy, aged 12 years, a papillomatous mass. Histologically it had the structure of tubercle.

Other papers are by Koeber (*Zeits. f. Aug.*, V. 10, p. 146); Stephenson (*Trans. Ophth. Soc. U. K.*, May, 1903); Hepburn (*Tr. Ophth. Soc. U. K.*, V. 37, p. 190) and Valli (*Clin. Oculistica*, Vol. 1, p. 284).

Plasmoma of the conjunctiva. In 1874, Waldeyer introduced the term plasma-cells for certain cells of the connective tissue. Von Marschalko (*Zeits. f. Augen.*, Feb., 1913) attributes their origin to the



Plasmoma of the Conjunctiva (Hiwatari). Showing Russell's bodies and connective tissue between epithelium and tumor.

lymphocytes of the blood, which Rados also considers most probable. Normally, they occur in the bone marrow, spleen and lymphatic glands. Pascheff described in 1908 tumors of the conjunctiva, which consisted chiefly of plasma cells and which he called *plasmoma*. The two cases reported by the writer were characterized by lobular form and smooth surface, and were located in various portions of the conjunctiva, chiefly in the retrotarsal folds. Besides plasma cells, they contained numerous polynuclear leucocytes and lymphocytes, which indicated their local inflammatory nature. This was confirmed in both cases, especially in the first, which also showed trachoma in the cicatricial stage and pannus.

See p. 3055, Vol. IV, and p. 10253, Vol. XIII of this *Encyclopedia*.

Kazuo Hiwatari (*Amer. Jour. of Ophth.*, Oct., 1918) reports three cases of plasmoma of the conjunctiva (Pascheff) with histologic ex-

amination of the tissues. He believes that plasmoma of the conjunctiva should not be regarded as a new-growth.

Since the first publication of Pascheff numerous cases have been reported from different countries—Bulgaria, Hungary, Prussia, Russia and Japan.

Clinically this tumor appears at times as a diffused, again as a circumscribed, thickening of the conjunctiva or the cornea. Processes of irritation are rarely observed in these cases. Youthful individuals (below thirty years of age mostly) are affected. About half the cases (11 in 22) show trachomatous changes, as pannus of the cornea, trachoma follicles, etc.

A number of authors (Rund, Deutschmann, etc.) look upon this tumor as a true neoplasm of the conjunctiva; others (Pascheff, Rados, Sawada, Shikano, Fudiwara) regard it as a kind of *inflammatory granuloma* having a close relationship to trachoma.

Hiwatari (*loco cit.*) furnishes the following histories and histological reports:

Case 1.—Woman, age 26 years; farmer. History: Since ten years old the patient is supposed to have had trachoma; since the last two years she noticed a gradual swelling of both lower lids. The excised piece of conjunctiva from the right lower lid, with the tarsus, was sent for histologic examination. The conjunctiva showed distinctly a papillary overgrowth; the subepithelial tissue is diffusely permeated with typical plasma cells; other kind of cells are found sparingly only. Very marked is the appearance of Russel's bodies. Between the epithelium and the infiltration of plasma cells there is imbedded strata of connective tissue of different thicknesses; which we regard as scar tissue. This infiltration is of varied thickness; in one place it appears to be a real tumor. The epithelial layer above, which everywhere shows papillary hypertrophy, is more or less distinctly flattened by pressure. At another place, where the plasma cellular infiltration was only sparsely developed, the histologic picture is very similar to that of trachoma. Towards the lower portion, the fibrous connective tissue gradually increases; so that between the conjunctiva and the tarsus a layer of dense connective tissue is interposed. The latter here and there shows powerful development and hyaline degeneration. In the tarsus we again see a plasmacellular infiltration. The Meibomian glands are mostly atrophied.

Case 2.—Servant girl, aged 18 years. The general examination (except some glandular swellings) is negative. For years she has complained of slight secretion in both eyes, and of ptosis of the left upper lid. On everting the lid the conjunctiva was found visibly

thickened; in some places there were miliary nodules, some of them the size of a small pea. Slight scar formation can in some places be demonstrated. The lower conjunctiva is only slightly hyperemic. In the right eye no tumor formation can be demonstrated; but in the upper conjunctiva we have a trachomatous thickening of the conjunctiva. (See the illustration.) A nodule from the fornix shows almost exclusively typical plasma cells in dense formation; and polynuclear leucocytes sparingly present. In the center of the nodular accumulation of plasma cells lies a small elevation of tightly compressed lymphocytes which toward the periphery intermingle with the surrounding plasma cells, as shown in the figure. Russell's bodies are also present in large numbers. Between the epithelium and the tumor there is a stratum of dense connective tissue, which sends a few fine branches deeply between the plasma cells.

What appeared remarkable in this case is the presence of a fairly strong plasmacellular infiltration in that part of the conjunctiva bulbi immediately adjoining the tumor. This tissue was extirpated along with the rest and looked clinically absolutely intact.

Case 3.—A working woman, aged 20 years, with tonsillar hypertrophy and swelling of the lymphatics of the neck and paleness of the exposed skin. On the right side there was a marked ptosis; she could not open the eye spontaneously. On everting the upper lid, which could be done only with great difficulty on account of its rigidity, the tarsal conjunctiva and fornix showed a diffuse, hard thickening of pale color. The excised conjunctiva measured in thickness about 4 mm. The conjunctiva of the lower lid and the transition fold diffusely scarred; on the cornea above were pannus-like changes. The conjunctiva of the left eye also showed old trachomatous changes. The thickening of the conjunctiva also presents in this case massive accumulations of typical plasma cells; the other migratory cells are sparingly formed. Russell's bodies were not present. Deeply, the infiltration, as in the first case, becomes slighter; in its place a fibrous connective tissue, poor in cells, is found. Immediately beneath the epithelium, which is more or less flattened, is a thin sheath of scar tissue. A few connective tissue bands run obliquely or horizontally, joining the latter with the above mentioned deeper-lying scar. They divide the plasmacellular infiltration into several parts. (See the illustration.)

As can be seen from these descriptions, there is no doubt that these cases are plasmomata of the conjunctiva; and emphasize these conditions: (1) the presence of a distinct scar formation in all cases, (2) the appearance of plasmacellular infiltration in the conjunctiva ad-

jacent to the tumor, which clinically showed nothing pathologic, and (3) the existence of clearly visible trachomatous changes in the second eye. Rund and Deutschmann have regarded plasmoma of the conjunctiva as a genuine tumor, but Hiwatari's observations are opposed to that conception, as well as to the hypothesis of Rados.

We have come to look upon the plasmoma as a kind of inflammatory granuloma. The fact that plasmoma cases up to now have been



Plasmoma of the Conjunctiva (Hiwatari). Third case. Showing accumulation of plasma cells infiltration and fibrous connective tissue.

reported from trachoma countries only is in favor of this conception. Plasmoma is probably etiologically identical with trachoma, and can be distinguished from genuine trachoma by its appearance only. It is a well-known fact that granulating inflammation in general occurs in two forms, in a pathologic or anatomic sense as well as clinically. The one is a diffused exuberation of granulation tissue, while the other consists in the formation of the so-called inflammatory granuloma. As long as it is certain that trachoma is a kind of granulating inflammation, as generally accepted today, it is entirely natural that

in trachoma there is formed a tumor-like thickening of the conjunctiva; just as in tuberculosis solitary tubercles are developed.

See, also, p. 10253, Vol. XIII of this *Encyclopedia*.

Polypi of the conjunctiva are described as soft outgrowths covered with mucous membrane and attached by a pedicle; frequently arising from the transition fold, the tarsus or the caruncle. They may be multiple; they vary in size, and at times may protrude between the lids. They frequently follow irritation caused by foreign bodies. According to Elsching, a true polypus—that is, hyperplasia of all the layers of the conjunctiva—does not occur. They are, when found, he thinks, either granulomata, papillomata or fibromata; or polypoid changes in certain other growths, such as dermoids, sarcomata, etc. Excision effects a permanent cure.

See, also, p. 3056, Vol. IV of this *Encyclopedia*.

Polypi of the conjunctiva are mentioned in most works on ophthalmology, often with a good account of their histology, clinical characteristics and methods of removal. But, as Deschamps (*Ann. d'Oculist.*, June, 1903) points out, the important point in their causation, which he finds to be usually dependent on a foreign body, is ignored. The presence of a polyp demands careful search for the foreign body that causes it. These growths usually occur in children, and no history pointing to the presence of a foreign body can, of course, be obtained from the child or its guardians. Moreover the original accident has caused but slight irritation; and the injury has been forgotten before the growth attracts attention. The offending particle is often very small; and may even be removed along with the growth, without being noticed. Deschamps reports two cases in which it was quite large; in one it was a piece of wood 7 or 8 mm. long, and embedded 1 cm. below the surface. In the other it was a hard scale of a fruit bud, which had certainly been lodged beneath the upper lid for more than a year.

A striking case of the kind is reported by Neeper (*Ophth. Record*, p. 540, 1903). A piece of broom straw, $\frac{7}{8}$ of an inch in length, had been lodged in the lower sac of the conjunctiva of a school-girl for 8 weeks. During that time she had glasses from an optician; and treatment for conjunctival disease from a general surgeon. There were three polyps; one at each end of the straw, and a third where it rubbed against the eye-ball. Probably, as Weeks points out, polyp of the conjunctiva always indicates an ulcerative process. But far more frequently than has been suspected, the origin of the ulcerative process is a foreign body in or beneath the conjunctiva.

Cosmettatos (*La Clin. Opht.*, Oct. 25, 1904); Brotherus (*Finska*

Lak-sallsk. Handl., Vol. 59, p. 1599) also record cases of conjunctival polyp.

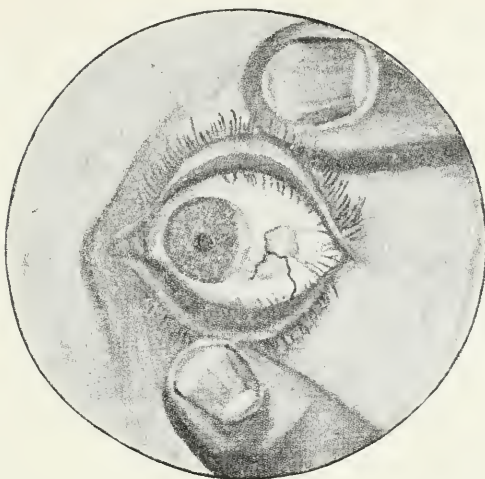
Sarcoma of the conjunctiva occurs most frequently at or near the margin of the cornea, occasionally in the semilunar fold, and rarely in the fornix, or other parts of the conjunctiva. A few examples have been observed attached by a pedicle to the palpebral conjunctiva.

Since the middle of the last century this growth has been differentiated from the general term cancer. A considerable number have been reported in literature, yet this does not accurately express their real frequency.

Sarcomata may be pigmented or non-pigmented; the former being more frequently observed. They may be single, yet multiple growths do occur. When removed they may recur at the original site or at some nearby point. They have been observed in the very young, but usually they appear between the ages of 35 and 60. They begin as a small, dark-brown or reddish, smooth, nodular elevation with a narrow base. The larger growths may overlies the cornea without any attachment to that tissue. In the earlier stages they are freely movable with the conjunctiva. This is one of their distinguishing features from epitheliomata. Occasionally they may be flattened and present a broad base; they are friable and bleed easily.

There is a diversity of opinion as to the degree of their malignancy; while, perhaps, not very prone to metastases yet the percentage of local recurrences after excision is quite sufficient to regard them as highly malignant. Intraocular invasion is not (owing to the density of the sclera) of frequent occurrence if the growth is removed early. Microscopically, these growths possess much the same arrangement as similar tumors in other parts of the body. They are composed of bundles of round or spindle cells; multinuclear cells may also be present. There are columns of these surrounded by fibrous tissue, forming an alveolar arrangement. Pigment granules are found within the cells, or in the tissues between the cells.

Prompt and active measures should be adopted in dealing with any suspicious growth of the conjunctiva. Many apparently innocent tumors should be regarded with suspicion; and at least a portion of the tumor should be submitted for a microscopic diagnosis. If the tumor has involved the sclera immediate enucleation is indicated. More serious involvement demands complete exenteration of the orbit. Prognosis is favorable only where early measures for complete removal are instituted. Surgical interference, radium, ionization, X-ray and desiccation are some of the most approved methods of dealing with these growths.



Epibulbar Sarcoma. (Heckel.)



Section of Epibulbar Sarcoma. (Heckel.)

See also **Sarcoma of the conjunctiva**, p. 11541, Vol. XV of this *Encyclopedia*.

Posey's (*Ann. of Ophth.*, Vol. 25, p. 430) case of *melanosarcoma of the conjunctiva* was in its second recurrence. It had been greatly and rapidly reduced by desiccation treatment. Primary removal ten years before was followed by a second operation (for recurrence) five years later; the conjunctiva as well as the cornea were involved.

Heckel (*Ann. of Ophth.*, Vol. 25, p. 474) reports a case of *epibulbar sarcoma* in a man aged 69 years, with no recurrence in five years. Five months previously the mass had been excised by another oculist; it, however, had returned with increased activity. The operative technic consisted of the use of the fingers as a means of exposing the eye-ball and the constant dropping of a normal salt solution to protect the cornea during the application of the Roentgen ray. The ray was applied by means of a specially constructed tube and speculum; exposures were from three to six minutes three times a week. During the succeeding six months the growth entirely disappeared.

Raia (*Jour. Ophth. and Oto-Laryng.*, Vol. 10, p. 307) reports a favorable result obtained by the use of gelatin disks of jequiritin after the method of Rampoldi and Capini. The author removed a primary spindle-cell sarcoma, 5 mm. by 4 mm., from the sclerocorneal junction of a man aged 49 years. Two weeks later it recurred. No. 1 disk was applied, and after waiting an hour, with no evidence of reaction, No. 3 was used. The reaction was most alarming. The patient, when seen three years later, presented a smooth scar hardly visible. In quoting Rampoldi, the writer states that the drug has an elective microbic action on the cells of the neoplasm and at the same time stimulating the normal tissue.

Klock (*Klin. M. f. Aug.*, Vol. 55, p. 361) has detailed three cases of ocular tumor treated with mesothorium and Roentgen rays. In the first case there was an *epibulbar melanosarcoma* covering the cornea. During the next three months the tumor was reduced to one-half its former size by one hour and thirty-five minutes' exposure to radium, and seven hours and thirty-five minutes to mesothorium. Less intensive treatment was continued, and one and a half years later there were only a few, pea-sized nodules of the tumor remaining, and the pigment had almost entirely disappeared. In the second case, there was a melanosarcoma of the ciliary body extending into the pupillary area and pressing the iris forward. Ten hours and twenty minutes' exposure to mesothorium reduced (in two months' time) the size of the tumor markedly; and brought the previously increased tension to normal. Continued weekly treatments of thirty minutes each

caused a further reduction in size. The third case was that of an epibulbar spindle-celled sarcoma, extending from the sclera over the pupillary area of the cornea. Under mesothorium it disappeared entirely.

Koller (*Arch. of Ophth.*, Vol. 41, p. 327) reports a case of epibulbar sarcoma, the first operation on which was followed by recurrence and local metastases. In spite of this, seven and a half years had elapsed since the final operation without any further appearance of the growth.

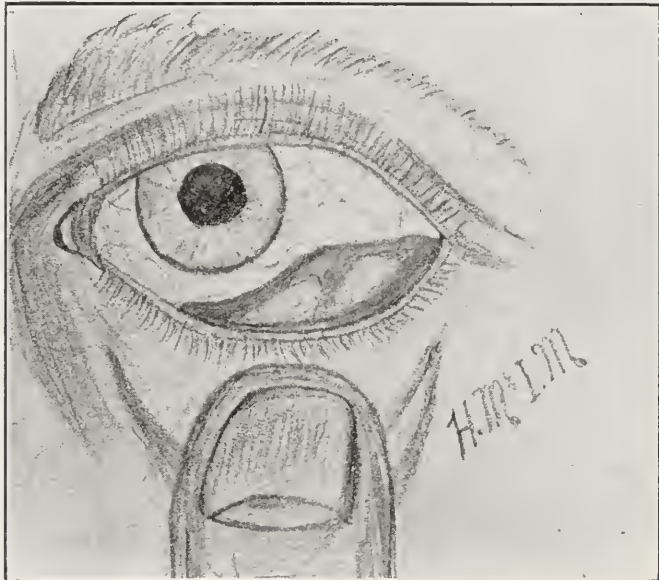
Verhoeff (*Arch. of Ophth.*, Vol. 41, p. 104) saw a case on which no operation had been performed. In the course of ten years the tumor had grown to the size of a baseball, had surrounded the eyeball, and had drawn it completely outside the orbit. Yet the globe was not invaded by the tumor, except at the upper limbus, where it had replaced the cornea and sclera to four-fifths of their depth. The patient died from metastases. The absence of a tendency to invade the eye cannot, therefore, be taken as indicating a lack of malignancy.

Lauber (*Zeits. f. Aug.*, Vol. 22, p. 545) records a case of diffuse melanosarcoma of the conjunctiva where, notwithstanding exenteration of the orbit, including the lids, there was metastasis three years later in the skin of the neck and back, with mental disturbance accompanied by deafness. Small pigment nodules were present in the iris of the fellow eye at the time blindness developed, and the patient took his life. Necropsy showed recurrence in the orbit and disseminated pigment nodes in the cortex and medullary substance of the brain. Miliary nodes were present in practically all the internal organs, save the liver. The second eye showed melanosarcoma of the ciliary body, iris, sclera, orbital tissues and muscles. The blindness was assigned to pressure of the enlarged hypophysis upon the optic nerve.

In Trapeontzeff's (*Arch. d'Opht.*, Vol. 32, p. 492) case of melanosarcoma the neoplasm had probably arisen from the conjunctiva of the lower lid. It was formed of large, polygonal cells with little protoplasm and round or oval nuclei. The perithelium of the smaller vessels was proliferated in several layers, closely surrounding the adventitia. In most instances the sheath of new cells contained some that were undergoing mitosis. The author therefore regarded this specimen as a pigmented endo- or perithelioma.

Kellermann (*Zeit. f. Aug.*, Oct., 1908) reported a case of recurring epibulbar melano-sarcoma in a woman aged 40. The original spot had been noticed when she was 17. Becker (*Ophth. Rec.*, Vol. 23, p. 468) observed a conjunctival melano-sarcoma in a child aged 13 years. The growth was present at birth in the form of a pigment spot. Coats

(*Arch. of Ophth.*, Vol. 44, p. 235) described a lymphosarcoma of the left conjunctiva of two months' duration, in a woman aged 29 years. A pedunculated, pale-red mass arose from the whole extent of the upper fornix; and there were several tuberculated masses in the lower conjunctiva. Following removal there were repeated recurrences; finally, extension into the orbit; enlargement of a cervical gland; loss of health and jaundice. The masses in the conjunctiva (microscopically) showed the structure of lymph follicles, with certain slight



Tumor-like Masses in Hyperplastic Subconjunctivitis. (Morton.)

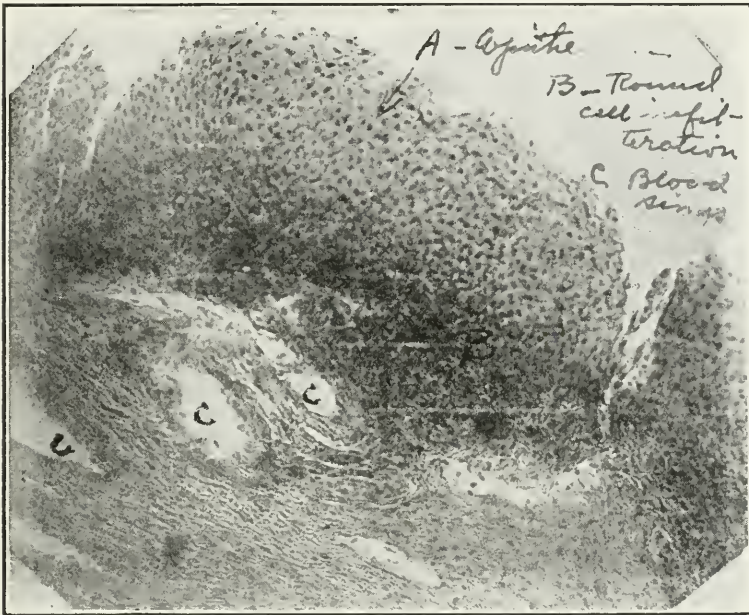
differences. The large mass in the upper fornix consisted of cells similar to those found in the smaller collections but with a greater tendency to a diffuse infiltration of the surrounding tissue. The recurrences indicate a highly malignant type.

Jean (*Arch. of Ophth.*, Vol. 42, p. 512) presented a case of lymphosarcoma of the conjunctiva in a man aged 55 years. The growth, which appeared as a general thickening and infiltration of the structures involved, affected the whole of the palpebral conjunctiva of the left eye; also the bulbar conjunctiva to within a few mm. of the limbus.

Fosmark (*Ophth. Rev.*, Sept., 1908) reported a case of bilateral, symmetrical, epibulbar leucosarcoma in a man aged 62. A growth had been observed for a year on the left eye; and on raising the right

upper lid a smaller one was found upon the right globe. Treatment with iodides, mercury and arsenic had no effect. The growth in the left eye was then removed.

Cosmettatos (*Klin. M. f. Aug.*, p. 273, 1905) states that leucosarcoma is much rarer than melanosarcoma. These tumors have a tendency to spread over the conjunctiva, but rarely upon the cornea and they do not penetrate into the eyeball. The author's case resulted from injury.



Section of Tissue in Hyperplastic Conjunctivitis. (Morton.)

Rschanitzin (*Klin. M. f. Aug.*, 1909) reports two cases of round-cell leucosarcoma of the conjunctiva. The first occurred in a seven-year old girl; the second in a man of 68 years. In the latter both eyes were affected. In one the growth was in the upper cul-de-sac, and in the other in the conjunctiva of the lower lid. There had been no recurrence at the end of three years.

Betti (*Ann. di Ott.*, Vol. 40, p. 647) reported a sarcoma of the bulbar conjunctiva in which there was entire absence of pigment. The growth followed trauma and developed independently in two areas.

See, also, Casolino (*Arch. di Ott.*, Vol. 23, p. 383, 2 ill.); Schwenk (*Ophth. Rec.*, 1909, p. 573); Wolfe (*Amer. Jour. of Surg.*, Aug., 1915); Wilder (*Ophth. Rec.*, 1909, p. 126); Del Monte (*Zeits. f.*

. Aug., Jan., 1908); Gallemarts (*La Clin. Opht.*, 1909, p. 526); Braunschweig (*Klin. M. f. Aug.*, Feb., 1908); Tertsch (*Ophth. Gesell. in Wien*, May, 1908); Petronio (*Pathologica*, Vol. 8, p. 17); Inoué (*Nippon Gank. Zashi*, Jan., 1915); Jessop (*Ophth. Soc. U. K.*, Vol. 34, p. 100); Sugita (*Nippon Gank. Zashi*, March, 1913) (Leukosarcoma); Selenkovski (*Russk. Vrach.*, Vol. 13, p. 552) (Diagnosis); Jean (*Arch. of Ophth.*, Vol. 46, p. 370); Wenzel (*Zeits. f. Aug.*, Vol. 23, p. 254); Kurkoff (*Sibirsk. Vrach.*, 1915, p. 330).—(D. F. H.)

EPIBULBAR TUMORS.

Although the term *epibulbar* is, in this connection, generally used to designate those growths beginning in or mostly situated on the bulbar conjunctiva, yet it is not confined to this use, but is often employed to locate neoplasms that are really *limbal or corneal*. Of course the origin of the term gives one the liberty to use it in connection with any external tumor of the eyeball. See, for example, Vol. V, p. 3444 of this *Encyclopedia*. For the rest the student is referred to the various sub-titles of this section and to the headings of the *Encyclopedia* that treat specifically of each new-growth under the caption of the particular ocular organ or tissue.

Thus, all tumors of the *sclera* are epibulbar tumors. In addition a few examples of these neoplasms are discussed mainly because their reporters prefer to speak of them as *epibulbar*, rather than as of scleral, corneal, conjunctival or other origin.

Epibulbar carcinoma. A well studied instance of this neoplasm is furnished by de Schweinitz and Shumway (*Archives of Ophthalm.*, July, 1913; abst. *Oph. Review*, Jan., 1914). Although a considerable number of cases of epibulbar carcinoma have already been recorded, the disease is of sufficient rarity to render it advisable to record fresh cases, especially when a careful microscopic examination has been made, as in the present instance.

The patient who came under the author's observation in November, 1912, was a man of 34, and had no symptoms or history of any importance with the exception of syphilis eleven years previously (Wassermann test positive). Fifteen years previously he had noticed a small, yellowish-white papular growth, the size of a split-pea, at the inner corneal margin of the left eye. A year later this had been destroyed with the actual cautery. Following this, the growth rapidly enlarged and then remained stationary for four years, and then again rapidly increased to such an extent that it protruded between the lids and reminded him of a strawberry. One year before he came

under observation the growth underwent a species of softening and liquefaction.

Three months after enucleation there was a recurrence in the upper and inner portion of the orbit, which necessitated exenteration. Eight months later there was no further sign of recurrence. The enucleated eye had its anterior segment covered by a tumor mass, which measured 27 mm. across, and extended backward along the outer side of the sclera a distance of 6 mm. on the temporal and 4 mm. on the nasal side. The growth appeared to consist of two lateral masses, one on either side of the former site of the cornea; the portion on the nasal side being 8 mm. thick and that on the temporal 5 mm. Between them was a depression where the cornea had been replaced by a faintly-staining tissue, which measured 2 mm. in thickness. The lens was displaced forward and to the temporal side, pulling the ciliary body away from its scleral attachment. The retina was totally detached.

Microscopical examination showed a typical squamous-celled carcinoma, developing from the conjunctiva. The cornea was replaced by a dense connective tissue, into which the columns of epithelial cells had extended from the temporal side to a short distance in front of Descemet's membrane. The growth, although involving the perivascular spaces of the perforating ciliary vessels, had not succeeded in reaching the interior of the globe. The recurrent nodule in the orbit showed the same type of growth.

In considering previously reported cases, the authors found that out of 53 cases perforation occurred in 20, showing that although the cornea and sclera offer a considerable resistance to the growth of the tumor, especially if Bowman's membrane be intact, still perforation may be expected in a considerable number of cases. From this they deduce the opinion that if the growth is of small size near the limbus, deep excision may be practised, but only if the patient can be kept under close observation. Growths at a distance from the limbus may be excised with less danger of recurrence. In the authors' case the growth first made its appearance at the early age of 19 years.

Epibulbar and palpebral carcinosis of the conjunctiva. This rare condition is reported by M. McBurney (*Klin. Monatsbl. f. Augenheilk.*, 53, p. 106). A woman, aged 67, suffered the last twenty years from frequent inflammation of her eyes. In the spring of the year of the report the right eye was much inflamed and painful. In the palpebral fissure the right eyeball appeared as a pale-reddish nodular ball without demarcation of the cornea and sclera. The lower fornix was of normal depth, but the lower lid showed less resistance and, like

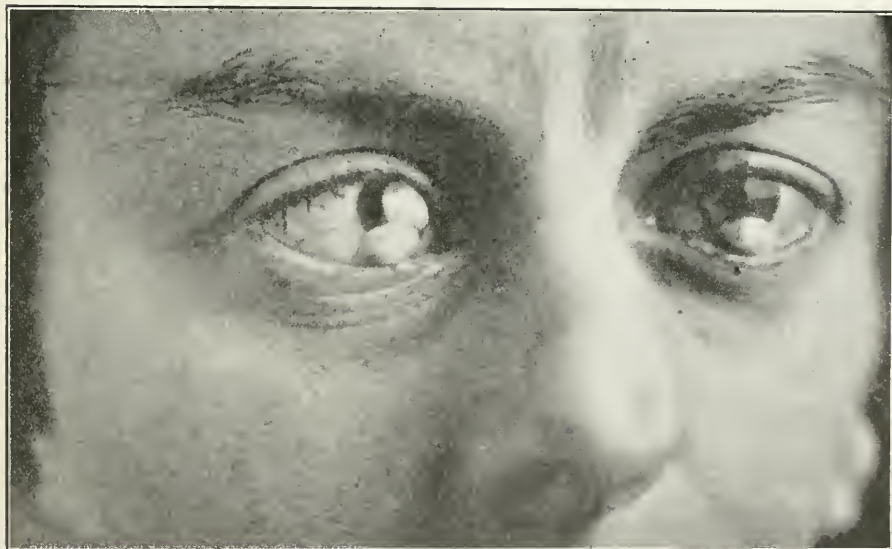
the eyeball, plica and caruncle, was covered with the same pale-reddish tissue. The conjunctiva of the upper lid showed chronic catarrhal inflammation with papillary swelling. The general examination revealed myodegeneration of the heart with albuminuria, but no sign of an internal carcinoma, and no enlargement of the cervical glands. Exenteration of the orbit under local anesthesia was followed by plastic closure of the orbit with the skin of the lids.

Microscopically, the tumor was a cornified, flat, epithelial carcinoma, which started from the lower limbus, penetrating through the perivascular spaces of the anterior perforating ciliary vessels. Its ulceration caused intense reaction: numerous plasma cells and round-celled infiltration, without giant cells, of the adjacent tissues, general congestion, iridocyclitis with anterior and posterior synechiae, obliteration of the sinus of the anterior chamber, infiltration of the choroid and optic nerve, and endophthalmitis. As usual in these cases of flat-celled epithelioma, there were no metastases.

Zentmayer (*Trans. Amer. Ophth. Soc.*, V. 17, p. 340) contributes a noteworthy case report of a patient with *multiple dermoids of the eye ball* with other anomalies. The patient, a female, aged 32 years, single, was observed in the author's service at Wills Hospital. The face is of a masculine type, and its conformity is irregular. The forehead is large, the nose awry, the fissure of the mouth extends on the left side half-way to the ear lobe, the angle being deflected downward. In advance of the lobe of each ear there is a supernumerary tragus. On the right side this consists of a serrated fin of cartilage and skin. On the left side the mass is bilobed and there is a small fistula posterior to it, probably an incomplete supernumerary external auditory canal.

In the right eye, overlying the sclero-corneal margin below, there is a growth measuring about 5 by 8 mm., and having an elevation of about 3 mm. The axis of the mass is 15° ; one-half is upon the sclera and one-half upon the cornea. It has a pultaceous feel and is of chamois color.

A second smaller growth springs from the surface of the cornea near its summit. It is somewhat conical in shape and leukomatous in appearance. It measures approximately 4 by 6 mm. and has an elevation of 3 mm. There is a narrow zone of opacity in the cornea about the base of the growth, extending to within 1 mm. of the limbus, from 60 above to 105 below. The corneal tissue is clear over a narrowing band extending around the lower and inner margin of the growth. There is a very shallow notch in the margin of the upper lid, in a position corresponding to the apex of the corneal tumor



Zentmayer's Case of Multiple Dermoids of the Eyeball.

This also is a congenital condition. In the left eye there is a sclero-corneal dermoid almost symmetric with that in the right eye.

Both marginal growths had well-developed white hairs growing from their surface. All three dermoids were removed—the right external rectus was advanced, the internal and superior recti were tenotomized, the supernumerary tragi were removed, and the left macrostomia was corrected by denuding the mucous membrane and removing some of the fibers of the orbicularis oris.

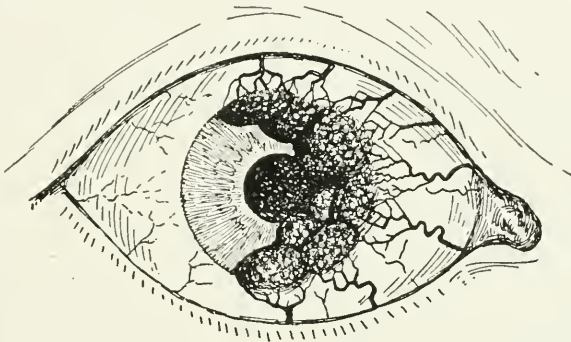
Microscopic examination of the specimens showed dermoid growths.

Epibulbar epithelioma. Grandélément (*La Clinique Ophthal.*, June, 1913) reports the case of a woman sixty years of age with a swelling about almond size, extending from the limbus to the caruncle. It was not ulcerated, and had started at the limbus many years previously. As the mass was too large to excise, the author had it exposed to the X-ray, and a month later nothing remained but a roughened red surface. A month following this a lesion of the same variety appeared on the edge of the upper lid, the size of a large pea. Two applications of radium cured this in eight days. The author comments upon the advisability of the rays in such cases to prevent great loss of tissue. It is possible to have a recurrence, especially in the eye, as the delicate tissues contraindicate a strong exposure. This is the first tumor of the kind cured by the above mentioned means. The X-ray is advised by the writer for (1) all cases of epitheliomas and sarcomas, hard cancers and lipomas; (2) majority of cases of dermatitis, dry or moist; (3) all varieties of vascular affections and angiomas.

L. Casolino (*Archivio di Ottalmologia*, 21st year, p. 540) also describes two cases of *epibulbar epithelioma*. In the first a very large tumor completely concealed the eyeball and protruded between the lids. It was adherent over the whole cornea and over a great part of the sclera, reaching on the outer side to within 4 mm., and on the inner side to within 20 mm., from the entrance of the optic nerve. Microscopic examination showed most of Bowman's membrane to have disappeared, although the substantia propria was not involved in the neoplastic proliferation. Only the most superficial layers of the sclera were infiltrated with tumor elements. The author regards the substantia propria and especially Descemet's membrane as the chief protective structures of the cornea. In both tumors plasma cells were found in abundance.

Albert C. Snell (*Trans. Am. Ophth. Soc.*, 1916) describes the successful treatment of an *epibulbar melanosarcoma* with the X-ray. The history of the case (which seemed very unfavorable for any sort of treatment) is as follows: An Italian, aged thirty years, first came

September 15, 1913, because of a growth on his right eye, which, he stated, he had first noticed five years before. He said that he had been treated by several different oculists, and that the growth had been removed on five different occasions. At this time the growth occupied two-thirds of the inner corneo-conjunctival limbus, lying almost entirely on the cornea, and reaching the inner edge of the pupil, slightly covering it. The mass was firmly adherent below, although the outer edge slightly overlapped the subjacent corneal tissue. The entire mass was dark seal-brown in color, the upper half being slightly darker than the lower. It was divided into eight distinct lobules, differing but little in size, each lobule having a nodular but unbroken surface. The entire mass was roughly crescentic in shape, the periphery of the arc measuring 26 mm. The crests of the lobules



Epibulbar Melanosarcoma of the Limbus. (Snell.)

reached different elevations, being about 2, 3, and 4 mm. high. Entering the mass from the nasal and the superior bulbar conjunctiva there were eight dilated, branching blood-vessels. The nasal third of the cornea was perfectly clear; the pupil reacted promptly to light stimulus, and the ophthalmoscope revealed no alteration from normal in any of the fundus structures. V. = 20/20.

It occurred to Snell that in view of the fact that the growth was *apparently superficial*, x-ray treatments might be of value. Therefore 12 treatments were given, the first October 31, 1913, the last January 31, 1914.

The technic employed was:—

The tube used was a protected lead-glass diaphragm, tube being placed as close to the eye as the glass cone would permit, which was about five inches from the target. A medium soft tube was used, two to four minutes being the time of exposure. (Dosage not measured at this time.) A saturated solution of boric acid was kept constantly

flowing over the cornea during each treatment. Improvement was noted after the fourth treatment. Treatments were discontinued when two-thirds of the area was healed.

Six weeks after the last treatment the entire tumor had completely disappeared. The cornea was smooth, perfectly clear, and had resumed its normal contour. At the limbus, and extending into the conjunctiva beyond, there were several irregular islands of pale-brownish pigment deposits, some 1 x 2 mm., others mere dots. These pigmented areas were not elevated, and there was no macroscopic evidence of any thickening of the conjunctiva or of the presence of any blood-vessels. The man was seen again three months later, at which time there was no evidence of any recurrence. In August, 1915, the report was "no more eye trouble."

The case reported was of the usual type of melanotic, epibulbar sarcoma of the limbus. Edward A. Shumway examined the slide and wrote that "the cells are of the mixed round and polygonal shape, which are usually found in these tumors, and in the little nevi from which they frequently develop. They are arranged in alveoli, and separated by bands of connective tissue. The amount of pigment is not great, so that the cellular structure is not concealed. There is also a moderate amount of round-cell infiltration in parts of the tumor, indicating an inflammatory reaction of the tissues."

The principal point of interest in this case is the result obtained from Roentgen therapy. In the literature Snell found but a single case (Braunschweig) in which *x-ray* treatment had been used. In this case treatment was given after complete excision, and there was no recurrence for three years. In the present case the treatment was undertaken at the time the tumor had reached its maximum growth and without an excision preceding the treatment.

Epibulbar myxoma. L. Mancione (*Archivio di Ottalmologia*, 21st year, p. 300) reports an example of this rare tumor in a man of 56 years, who had noticed for about six years a small growth at the external canthus, which during the past six months had increased in size, and now protruded somewhat between the lids. The growth, which measured 10 mm. in the horizontal diameter, 8 in the vertical and 6 in depth, was almost spheroidal, of a rose color, smooth in surface, fairly soft and freely movable on the sclera beneath the conjunctiva, to which it was also only loosely attached. It was removed, and proved on histologic examination to be almost entirely composed of myxomatous tissue, lying between scattered connective tissue fibers, with a few nuclei.

F. H. Verhoeff (*Archives of Ophthalm.*, March, 1912) describes an

unusual case of *epibulbar sarcoma*, and remarks that histologically the tumor did not differ in structure from a melanotic spindle-cell sarcoma of the choroid, and its origin was no doubt similar—that is, from chromatophores of the corneal limbus. The duration of the case, eleven years, was apparently longer than the average duration of fatal cases of choroidal sarcomata, but it must be remembered that the latter are usually not observed until they are of considerable size. In 1903, after an analysis of most of the previously reported cases, R. G. Loring and the writer arrived at the conclusion that the view then prevailing as to the benignancy of epibulbar sarcomata was erroneous, and that they were, in fact, so highly malignant that enucleation should be resorted to as soon as the diagnosis was certain. The correctness of this conclusion seems to be exemplified by the present case. As a visual demonstration to patients of the urgency of early operation, he presents illustrations, which he believes should prove most useful. In view of the large size of this tumor, which is one of the largest, if not the largest, of its kind reported, it forms a striking illustration of the fact that epibulbar sarcomata have almost no tendency to invade the globe. In the literature there are only about five cases, including one examined by the writer, in which it is highly probable that an epibulbar sarcoma invaded the interior of the eye, and even in these the possibility of an intraocular origin of the growths cannot be absolutely excluded.

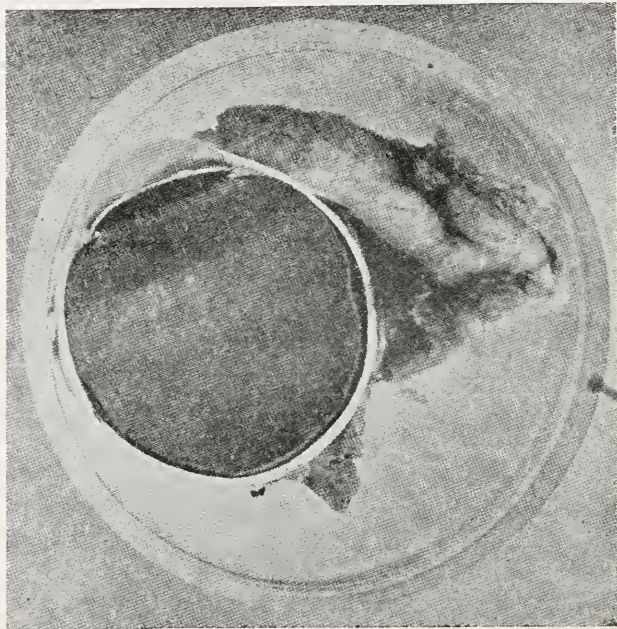
Carl Koller (*Arch. Ophth.*, July, 1912) reports two cases of *epibulbar sarcoma*, operated on by him eight and six years before. There had been no recurrence in either case. The author does not believe it is justifiable to enucleate or eviscerate in the early stages of the growth and believes it is more rational to follow the advice of Fuchs, who practises radical excision of the tumor mass, followed by cauterization of the basal tissues, and resorts to enucleation only in case the tumor is so large that the greater part of the conjunctiva would have to be excised with it. Koller emphasizes the necessity of thoroughly cauterizing the underlying tissues after removal of the growth.

Primary epibulbar leucosarcoma. A case of this rare neoplasm is described and depicted by R. H. Dickson (*Ophthalmoscope*, p. 146, March, 1914). A shoemaker, aged 77, in November, 1904, showed on the right eye, a large, purple-colored, fleshy, episcleral growth completely surrounding the upper half of the cornea, extending from the corneal margin back as far as could be seen.

The growth was firmly adherent to the underlying sclerotic, as well as the conjunctiva covering it. The lens showed signs of incipient cataract, but the fundus could be seen fairly well, and appeared nor-

mal. V = 6/24. The patient stated that he had first noticed the growth five years before, as a small nodule on the outer side of the cornea. It had gradually increased in size, and spread around the upper half of the cornea. There was no history of injury. At times he suffered from some pain in the growth, but, as a rule, there was little or no discomfort. (See the accompanying figure.)

A piece of the tumor was excised, and forwarded to a pathologic institute for examination. It was reported to be simple granulation



Primary Epibulbar Leucosarcoma. (Dickson.)

tissue. In the left eye was a mature cataract, which was successfully operated on, the eye being in other respects normal.

In May, 1905, the man again presented himself at the infirmary. The tumor on the right eye had considerably increased in size, and presented the appearance of a large, dark, purple-colored, fleshy, episcleral mass encircling the upper half of the cornea. It was thickest above, where it overlapped the corneal margin, and extended as far back as could be seen when the eye was rotated downward. It was of firm consistence, closely adherent to the sclera and to the conjunctiva covering it. The cornea was clear; the conjunctiva slightly hyperemic; the lens opaque. The lids could still be closed without difficulty. The vision was reduced to perception of light; the pupil acted nor-

mally to light and to accommodation; and the projection was good. The ocular movements were unrestricted except perhaps in the upward direction.

A further portion of the growth was excised, and sent for examination to W. H. McMullen, who reported that it was a small, round-celled sarcoma and advised enucleation.

On June 1, 1905, the patient was admitted to hospital, and June 4, the eye and the growth were excised *en masse*, and immediately put into a 10 per cent. solution of formalin.

The patient was seen on November 4, 1905. He looked in all respects the picture of health. There was no sign of any local recurrence of the growth, and careful examination showed lungs, liver, spleen, and kidneys to be in all respects normal. He died on November 24, 1910, from natural causes. There was no recurrence of the growth.

A case of *bilateral, symmetrical epibulbar leucosarcoma* is reported by Forsmark (*Carol. Medico-Chir. Inst.*, ix, 1908; abst., *Oph. Rev.*, Sept., 1908) in a man sixty-two years of age. He had observed for a year a fleshy nodule on the upper-outer aspect of his left eyeball, causing some protrusion of the upper lid. Vision had been deteriorating, but there was no pain or tenderness. At the time of observation the left upper lid was seen to be pushed forward by a tumor so situated upon the upper half of the globe that its lower or anterior border embraced the upper edge of the cornea from the outer to the inner end of its horizontal meridian. This free border was the thickest part of the tumor and had a thickness of 4 or 5 millimetres. Its thickness gradually diminished in an upward direction, and the posterior border could not be defined as it lay farther back than the upper fornix. The color of the swelling was of a yellowish-brown, its surface smooth, and its appearance translucent and "bacon-like." It felt elastic and quite fixed in the sclera. There was no tenderness on handling. The cornea was clear, with a moderate amount of regular astigmatism. Media; fundus and field of vision normal. Corrected vision = 0.7. In addition to the protrusion of the eyelid there was a certain degree of protrusion of the globe itself. A similar tumor was discovered on raising the upper lid of the right eye, but this was much smaller than the one on the left eye. Corrected vision of right eye = 1. A small preauricular gland was palpable on the left side but none on the right. Portions of the tumors excised for microscopic examination showed no organisms. In structure the tissue was highly cellular, the cells being chiefly small round or oval cells with well-stained nucleus. Among these, much fewer in number but 2 or 3 times as large, were oval or round cells with clear protoplasm and a large clear nucleus. Some of these were larger than others and contained as many as six or seven

nuclei. There were a few Ehrlich mast-cells but no plasma cells and no vacuolated cells. Some pigment was found giving the iron reaction. The only connective tissue was in the form of fine septa passing out for a very short distance from the blood vessels. Sections from the tumor of the left eye (presumably the older) showed great thickening of the adventitia of the blood vessels, and the much contracted lumen filled with proliferating endothelial cells. The fine septa of connective tissue were also thickened. The contraction of these had led to the appearance, in parts, of thickened vessels and connective tissue septa crowded together, in the interstices of which were the degenerated remains of tumor cells. The tumor tissue was for the most part separated from the conjunctiva by a layer of connective tissue, but here and there it reached quite up to the epithelium.

The author mentions a number of conditions which must be taken into account in making the diagnosis, and discusses in detail the points for and against unpigmented naevus, epithelioma, lymphoma, amyloid degeneration of the conjunctiva, and the granulation tumors of syphilis, tubercle and lepra. Having eliminated all these, he falls back on a diagnosis of primary, bilateral, epibulbar leuco-sarcoma. The prominence of the left eye he attributes to the existence of a third tumor in the left orbit.

The patient was treated with potassium iodide and mercury, and later with arsenic, but with no result in either case. Finally the tumor on the left eye was removed piecemeal and the wound healed normally. The author is prepared, however, to hear of recurrence, and cannot propose any treatment beyond partial excisions to relieve local symptoms.

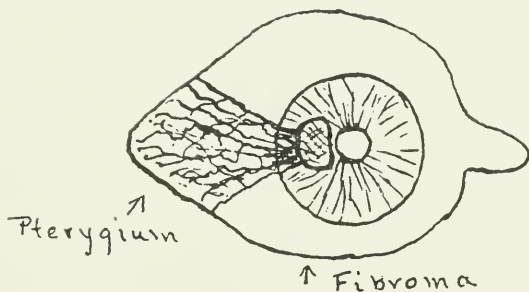
In discussing his case of *primary epibulbar melano-sarcoma*, Gross (*Prac. Med. Series, Eye*, 1910) believes that since a melanoma develops from a proliferation of pigment cells, the chromatophores, the growth should be called *chromatophoroma*. A case is reported in a young woman of 21 years who for six months had been developing a pigmented growth at the nasal limbus of the cornea. The growth was removed with a knife and its base eurented. Twenty months had passed without relapse. A second case is reported of a young woman of 22 years, who had a pigment tumor growing from the iris. It had been two years in developing, is still small and is giving the patient no trouble. She refused operation.

TUMORS OF THE SCLERA.

This subject has already been fully treated under various **Sclera** headings in Vol. XV of this *Encyclopedia*, especially on p. 11607. A few additional examples are referred to here.

A *pigmented nevus of the sclera* was observed by Posey (*Ophthalmic Year-Book*, 1916) that involved nearly the entire sclera in a young Chinaman. A brown to black nevus occupied the right side of the nose, eyebrow, forehead and temple.

de Schweinitz and How observed an *epibulbar (scleral) growth*, 2 mm. by 4 mm. by 1.5 mm. in a middle aged male, which had reappeared eight months after cauterization with trichloroacetic acid. It was dissected from its bed: but a second typical recurrence took place eight months later. Radium was applied, followed by a sharp reaction, at first mild conjunctivitis, later a mild iritis, and for a short period hypopion. Later the eye quieted and the growth diminished one half in size. The growth contained stratified squamous epithelium; portions suggested cells which are seen in sarcoma. Later studies suggested that the inclusion of epithelial cells be regarded as an early epithelioma.



Snell's Case of Epibulbar Melanosarcoma of the Scleral Limbus.

The authors also detailed the case history of a small pigment mass 1 mm. by 1.5 mm. in the eye of a woman, aged 25 years. It was situated 1 mm. from the corneal margin on a vascular base. Sections gave the appearance of *melanotic round-cell sarcoma*. The fact of such growth developing from collections of pigmented cells, so-called melanoma, was referred to.

In Snell's patient there was a large crescentic epibulbar *melanosarcoma* of the scleral limbus. The man, an Italian, aged 30 years, had had the mass removed some three months before. The recurrence occupied two-thirds of the nasal limbus, and was made up of eight distinct lobules supplied by a similar number of blood vessels. The circumference of the mass measured 26 mm. and was from 2 to 4 mm. high. Roentgen-ray treatment was administered with a medium soft tube, two to four minutes being the time exposure, the cornea being protected by a constant flow of saturated solution of boric acid. Improvement was noticed after four treatments. Treatments were

discontinued when two-thirds of the area was healed. Six weeks later the entire tumor had completely disappeared. Marple's patient had a (*scleral*) *epithelioma* of four weeks' duration. Radium was used. The chance of metastasis occurring was thought to be very slight.

TUMORS AT THE SCLERO-CORNEAL JUNCTION.

As pointed out on p. 3523, Vol. V, this zone is a favorite area for the origin of neoplasms, and it is proposed to speak of a few examples under the above caption. The new-growths most commonly found at the limbus corneæ are angioma, carcinoma (*epithelioma*), dermoids, papilloma and sarcoma.

Epithelioma of the sclero-corneal limbus. Marcel Davis (*Ophthalmology*, Oct., 1911) reports an instance in a woman, 65 years of age, who noticed, a year before, that her right eye was becoming red; she observed at the same time that the ocular conjunctiva was injected and complained of the difficulty she had to see in the sun-light.

A few weeks after, without noticing it, she was told that there was a little spot on the edge of the cornea. Two months before first examination the patient herself remarked on the limbus a tumor of the size of a grain of rice. This tumor was never painful, it gave the sensation of a foreign body, and very soon its volume increased. On first examination the eyelids closed normally, the conjunctiva of the under eyelid was injected, also the ocular conjunctiva on the nasal side, the cornea was vascularized at the inferior part. A tumor took up about the internal half of the anterior surface of the cornea and extended on the infero-internal part of the conjunctiva of the eyeball. The tumor was 8 mm. high, 6 mm. wide and 3 mm. thick. It was triangular, round-angled, with base down, very slightly sanded, of a grayish color, and consistent. The edges were sharp except on the inferior nasal part, where it prolonged itself in a conjunctival tumor with a small horizontal groove on its median part. The inner edge covered a part of the pupil. The conjunctival injection clearly extended to the tumor, which did not offer a trace of necrosis, of ulceration or hemorrhage. The temporal part of the tumor was easily raised by a stylet. The conjunctival part of the growth was also triangular, with round edges, the base extending with the base of the corneal tumor. It was very thin (about half a millimeter), smooth, pink and strongly vascularized.

The tumor was extirpated with a small knife; it was partially fixed to the cornea, and entirely fixed to the conjunctiva. The wound was cauterized with a galvano-cautery; the conjunctiva was not sewed. Dry dressing was applied during several days. The cicatrization went on very well, and six weeks after the cornea offered a pink coloration and no trace of relapse.

Dermoid at the sclerocorneal margin. Two cases under observation at about the same time at Wills Hospital, are described by Burton Chance (*Ophthalmology*, July, 1913). The first was a Russian boy of 15 years. A tumor, occupying an area of 3x7 mm. on the sclera and cornea, was present, and had been since birth, but was regarded as a birth-mark by his parents and, therefore, of no consequence. It was of a pearl-gray color and protruded between the closed lids. A few stiff hairs projected from its summit. It was dissected from the sclera and cornea, to which it was intimately attached, and the conjunctiva sewed over the raw area. The other tumor was in a 13-year-old Italian girl and was in the same position, lower temporal quadrant, on the cornea and sclera. It was not as large as the tumor in the former case, but was more pink, and the parents feared it was growing and might be malignant. It was more on the sclera than cornea. The same method of removal was carried out in both cases. Healing was uneventful. The subsequent examination of the tumors disclosed many characteristics in common, namely fibroelastic tissue, chiefly with a covering of laminated squamous epithelium. Fat cells, sebaceous glands and hair follicles with their retained shafts were common to each. In the case of the girl, there were epithelial islands and much pigment, which indicated that pathologic activity was going on.

Wm. Zentmayer (*Am. Journ. Ophthalm.*, July, 1918) reported, in a woman, aged thirty-eight years, *symmetric dermoids of the sclerocorneal margin* with a dermoid of the cornea of the right eye. The sclerocorneal growths were about the size of a white bean, of chamois color, pultaceous in feeling and presented several cilia projecting from the surface. The corneal tumor was somewhat conical, yellowish-white and projected between the lids. There were well-marked supernumerary auricles on each side of the head and there was a very marked megalastomia. The right eye was converged about 80 degrees. Marked scoliosis placed the heart on the right side of the spinal column.

At the first operation the sclerocorneal dermoids were removed and about ten days later the corneal growth was dissected off. Two weeks later the right external rectus was advanced and the internal rectus tenotomized.

V. L. Raia (*Journ. Oph. and Oto-Laryng.*, Oct., 1916) reports a case of *primary sarcoma of the sclero-corneal junction treated with jequirity*. Patient, a man, 40 years of age. Pathological diagnosis: spindle-cell sarcoma. Three years of complete absence of suspicious symptoms after the application of jequirity in the present case induce the author to think the cure permanent.

According to Rampoldi, jequirity has an elective necrobiotic action

on the cells of the neoplasm, while at the same time it stimulates the elements of the normal tissues around to a new and powerful activity by which the loss of substance is replaced.

The reader is also referred, in this connection, to George S. Derby's chapter on The Operative Treatment of Epibulbar Tumors, page 643, Vol. 1, of Wood's *System of Ophthalmic Operations*.

TUMORS OF THE CORNEA.

Under appropriate and separate headings most of these neoplasms have already been described and discussed in volume V of this *Encyclopedia*. Additional cases are reported below.

Cysts of the cornea are treated on p. 3691, Vol. V. An instance of these really rare growths (a *serous cyst*) is furnished by Dujardin (*Prac. Med. Series, Eye*, 1907). The patient, 42 years of age, consulted him on July 8, 1906, in regard to a small tumor of the right cornea which appeared about nine months previously and had slowly increased in size until it had become a discomfort. The cyst, which was situated at the internal portion of the cornea near the border, was 5 millimeters long vertically by 2 broad. The surrounding cornea was clear; no trace of pterygium; the growth did not encroach upon the sclera; eye was otherwise healthy; no conjunctival hyperemia. The cyst, which was excised close down to the cornea, did not involve corneal tissue. A superficial galvano-cauterization was done after the excision. Fifteen days afterward the eye was well.

Dujardin states that the pathogeny of corneal cysts is very obscure, developing, as they do, without apparent cause.

The reader will find an account of a case of *cyst of the cornea* by Frank in the *Annals of Ophthalmology* for July, 1905.

Pfingst (*Ophthalmic Year-Book*, 1916) observed a case of *dermoid* of the corneoscleral margin, in a girl aged 24 years. He recommends early removal after a child has passed the first year. Boyd reports a case of *dermoid growth* 5 mm. by 4 mm. at the inner corneoscleral junction following an injury five months previous. See, also, p. 3842, Vol. V of this *Encyclopedia*.

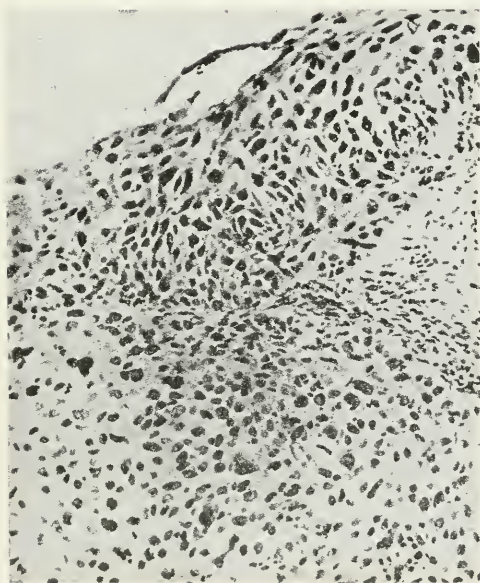
Epithelioma of the cornea is discussed on p. 3363, Vol. V of this *Encyclopedia*. To the matter there provided a number of cases are added here.

H. H. B. Cunningham (*Trans. Oph. Soc., U. K.*, Vol. 30, 1910) describes an instance in a man, aged 36 years, who came complaining of dimness of vision in his left eye.

About six years previous his left eye was injured by a chip of cement,



Epithelioma of the Cornea. (Cunningham.)



Epithelioma of the Cornea. (Cunningham.)

but only slightly, as he resumed his occupation on the following day. Until about eight months before he had no trouble either with his eye or sight. But at this period he noticed a "redness on the white of his eye," and three months later the sight commenced to fail, and had been steadily becoming worse. At no time had he felt any pain, the only inconvenience being the dimness of vision. No history of any similar condition in the family. There was a grey, semi-translucent growth projecting into and covering the inner half of the left cornea and of its pupillary area; it also extended backwards for about 0.5 cm. on to the conjunctiva, which was movable beneath it; the neighboring vessels were injected. The growth projected about 1 mm. forward from the cornea and was quite sessile throughout, and appeared to be of the same consistency everywhere except for a sausage-shaped small portion which was of more fibrous appearance. The whole growth appeared to be covered by epithelium, and its free border was sharply defined, standing out clearly and about 1 mm. above the rest of the cornea, which appeared normal throughout that portion not covered by the growth. The patient said he could only distinguish objects at a few feet and was unable to read with this eye. See cut.

Under cocain the greater portion of the growth was removed with a Beer's knife, and submitted for pathological report; there was little hemorrhage during this operation. A week later the pupillary area of the cornea had almost cleared up, the rest of the cornea, however, and the conjunctiva remaining affected. Vision now was found to be 6/6 in each eye and also J. 2 by holding the type so as to keep the line of vision away from the inner and lower edge of the pupillary area. Fundus quite normal, pupil active, and tension normal.

No enlarged glands in front of the ear or in the neck.

The pathologist reports "A pure mass of cells, there being no fibrous tissue present. The cells are large, irregular bodies, with well-marked nuclei and occasionally nucleoli. They are flat for the most part, are in places of a short oval or spindle shape, and arranged in close whorls. In the central portions of the whorls there are deeply-staining, somewhat pyriform masses like bare nuclei, and with a superficial resemblance to the Leishmann-Donovan bodies, but with Leishmann's stain no 'piroplasms' were seen." See the cut.

Cunningham is inclined to think that it is of the nature of an endothelioma.

Profeta relates a case of *primary epithelioma of the cornea*. His paper tabulates sixty-six cases from the literature of corneal and conjunctival epithelioma, classified according to location and other

features. Of these only four can with certainty be considered as primary epitheliomata of the cornea. The author's personal case developed on the cornea in a woman of 55 years, and on account of its rapid growth the eyeball was enucleated. Danis also reports a case that occurred at the corneal limbus of a woman of 65 years, and was removed locally, the wound being thoroughly cauterized.

M. Menacho (*Archivos de Oftalmologia*, July, 1915) describes a case of *pavement epithelioma of the cornea*. The tumor occurred in a man of forty-three years, and was said to be of eight months' duration. It was almost round, was located to the inner side of the cornea, and was rather more than four millimeters in its larger diameter. It was rosy in color, granulomatous in surface, and received its blood supply from some conjunctival vessels coming horizontally from the direction of the inner canthus. The patient's other eye had been lost as the result of an injury. The growth was dissected away at its base with a Graefe knife, the operation being completed by galvano-cauterization of the surface of implantation. Two and a half years later the eye was still sound. Microscopic examination showed that the neoplasm had been formed exclusively at the expense of the epithelium, and that it was primarily and entirely corneal.

Steinhort's (*Oph. Year-Book*, p. 318, 1916) case was most likely a primary basal-celled *epithelioma* of the cornea. The published report is accompanied by a review of the literature. Colombo found in a *dermoepithelioma of the cornea* neural and epithelial elements. Sometimes the prevailing structure is composed of epithelial plugs, while the neural elements are scarcely represented. In others the neural elements compose the major part of the growth. It is possible that the tumor represents an anomalous development of the conjunctiva, consisting of small angiomas with or without pigment. There is a new formation of neural and epithelial elements, the cells of the latter having undergone cystic degeneration.

Granuloma of the cornea. The best essay on this very rare neoplasm is that of M. Feingold (*Am. Journ. Ophthalm.*, July, 1919) illustrated by two cases. See, in this connection, p. 5630, Vol. VII of this *Encyclopedia*.

Case 1.—H. J., colored, laborer, aged 56, applied at the Charity Hospital Eye Clinic, Nov. 9, 1917, stating that, three weeks before, muriatic acid had splashed into his eyes and that the right one was so badly injured by it that enucleation had to be done two weeks later. The conjunctiva of the eyeball appeared reddish-white, the whole cornea grayish, and he could notice hand movements. Gradually a

grayish-red soft granuloma 3 by 3 by 2 mm. appeared on the conjunctiva of the eyeball at the lower temporal limbus, and a similar flat one 3 by 1.5 mm. at the upper temporal limbus.

Dec. 6, 1917, the lower granuloma was seen riding on the limbus with its greatest portion on the cornea, while the smaller granuloma was entirely on the cornea near the upper limbus. The cornea appeared at first glimpse quite clear in the peripheral portion, but this was due only to invasion of superficial and deeper vessels from all sides; through it the iris could be dimly seen. The central portion was whitish, opaque and slightly depressed, with irregular surface. Light projection and color perception were good.

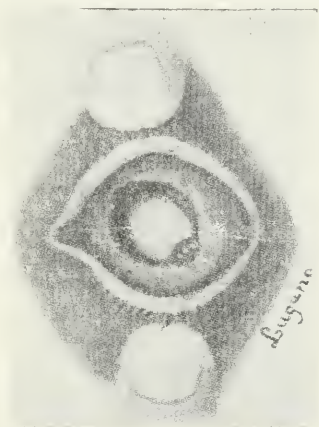
Later the upper granuloma moved 2 mm. from the limbus to the center, getting smaller at the same time and appearing more red; the lower granuloma also grew smaller and more flat. The central area of the cornea became more bluish-white and smaller, because encroached upon by the increasing ring of vascularization; the thickened, grayish-red conjunctiva of the eyeball extended on to the cornea forming a false pterygium in several places. This was especially noticeable at the seat of the lower granuloma, which in the meantime had moved from the limbus, leaving a narrow band of clear cornea between itself and the limbus. The upper nasal portion of the cornea cleared perceptibly and the patient could see faces.

Three months after the accident, the lower granuloma was smaller, triangular, and apparently pedunculated while the upper granuloma had entirely disappeared. During further observation even the lower granuloma faded away gradually and the whole cornea cleared sufficiently so that, about May 1, 1918, patient could read 2-inch letters close to the eye. During the whole time the tension was carefully watched and always found to be below normal on palpation. Only once did the tension seem to be increased. Treatment consisted only of dusting with ethyl-morphin hydrochlorid powder. See the figure.

Case 2.—E. B., a farmer, aged 42, called at the Charity Hospital Eye Clinic, Sept. 29, 1915, because of inflammation of his right eye, which had begun when some unslacked lime got into his eye three weeks before. The eye showed moderate ciliary injection; the corneal epithelium was markedly defective, the cornea itself being deeply injected and opaque, with a deep-seated, round, 3 mm., gray infiltration slightly below the center. There were 3 mm. of hypopyon.

The hypopyon soon became absorbed but recurred several times. Gradually a small, soft, reddish-gray tumor of granulation tissue appeared near the center of the cornea. Acetyl-salicylic acid, ethyl-morphin hydrochlorid, argyrol, atropin, and physostigmin (eserin)

were used to meet symptoms and indications. Repeated attacks of severe pain caused by increased intraocular tension finally necessitated enucleation which was done under local anesthesia, March 20, 1916. The eyeball was immediately placed in Zenker's solution, after



Case 1. Granulomas of the Sclerocornea. (Feingold.)



Case 2. Granuloma of Cornea. Mallory's Connective Tissue Stain:
× 24. (Feingold.)

hardening bisected at the equator and sectioned horizontally by Lee's dry celloidin method.

Histologic examination. In the conjunctiva only a few plasma cells are seen, but the epithelial cells have a tendency to desquamation. The cornea is slightly pressed in toward the anterior chamber in the central part. This was apparently caused by the lid bulging the soft-

ened cornea in, when pressing on the projecting growth. The cornea is about 0.6 mm. thick in the periphery, somewhat thicker in the central portion, where a mushroom-like growth is lying on the surface and is continuous with the corneal substance by its very short pedicle. The epithelium is missing on the whole corneal surface. At the limbus the epithelium of the conjunctiva projects for a short distance over the cornea, but is not in contact with it, forming a folded band which often folds back on itself toward the limbus. See the figure.

But for an isolated, cell-like structure here and there, Bowman's membrane is entirely bare of epithelium. It is continuous over the whole surface of the cornea, except for about 0.98 mm. in the center, corresponding to the pedicle of the growth. It is about 16 microns thick and seems to consist of two portions. The superficial one is about 3 microns thick and stains rather deeply with hematoxylin and purplish with Mallory's connective tissue stain. The posterior portion stains more like the corneal substance. The anterior portion is separated here and there to some extent from the underlying portion. Bowman's membrane, and to a slighter extent the adjoining lamellæ of the cornea, contain numerous, small, amorphous and more crystalline, yellowish-brown particles of different size (argyrol?). Bowman's membrane is everywhere in normal contact with the underlying parenchyma. In some sections, near the pedicle of the growth, masses staining intensely blue with hematoxylin are seen between Bowman's membrane and the parenchyma and also in the spaces between the next three or four layers adjoining. These masses are fine and linear or more lumpy and often mask the corneal structure entirely (lime?). Numerous vessels pervade the whole cornea, lying mostly in the anterior two-thirds. A few smaller vessels are immediately below Bowman's membrane. In the immediate neighborhood of all the vessels are seen cells, each with a long nucleus, staining deeper than the corneal cells, also an occasional eosinophil. The whole cornea is seemingly unaltered except that the fixed cells are evidently more numerous than normal. Higher magnification reveals some of these, at least, as possibly wandering cells, since their nuclei stain deeper blue and since two or three cells are at times seen in the same space. Except for the affected area, the cornea shows no differences in the arrangement and appearance as to color, etc., of the lamellæ, in spite of the marked opacity *in vivo*.

The affected area is about 2.8 mm. in the largest diameter and is consequently larger than the defect in Bowman's membrane. It is roughly lenticular in cross section, that is, thickest in the center. It occupies the middle layers of the cornea, leaving the posterior fourth

entirely free. Its edges are entirely in the deeper layers with comparatively unaffected corneal substance in front of it. Over the central portion, on the other hand, corresponding to the defect in Bowman's membrane, this area extends even through the anterior layers, and is here continuous with and forms the pedicle of the mushroom-like growth on the surface. In the affected area, the lamellæ have lost their parallel arrangement, have changed direction, and have a tendency to bend forward into the pedicle. The lamellæ are more widely separated and are possibly fewer in the center. The vessels are very numerous, especially near the pedicle. Between the separated lamellæ and surrounding the blood vessels, numerous cells of the following types are found: (1) cells, each with a large, pale vesicular nucleus: endothelial and young connective tissue cells; the nucleus is often smaller and distorted by the surrounding tissue; (2) plasma cells; (3) polymorphonuclear leukocytes; (4) occasional eosinophilic leukocytes; (5) small, round cells, apparently lymphocytes; (6) cells in mitosis, most probably of the type mentioned in group 1. The character and arrangement of the cells varies from place to place. Here the plasma cells prevail, there the polymorphonuclear leukocytes, etc.

The growth projects above the surface of the cornea about 0.93 mm. and is about 2.25 mm. in the greatest meridional diameter. It is button or mushroom-like, overlapping the cornea because it is bigger than the opening in Bowman's membrane, through which it is continuous with the corneal substance. Only in a small area does the growth appear more sloping on the surface and not overhanging. It is not covered by epithelium. On and near the surface, a network of fine fibers, arranged more or less parallel with it, is seen. These fibers have all the appearance of fibrin. Here they enclose an edematous area, there the network contains numerous leukocytes and traces of extravasated blood in other places. The skeleton of the growth is made up of more or less radially arranged fan-rib-like septums of connective tissue and possibly of some remnants of corneal tissue. Small and large vessels often showing bifurcations are very numerous. The vessels are arranged in a fanlike manner as in papilloma, and near the surface are seen rather large sinus-like cross sections, filled with blood. The space between the connective tissue groundwork and the vessels is filled with cells of various character. They are all of the same nature as those of the affected area of the cornea, but are more numerous and the relative frequency is here different, the cells having large, pale, oval nuclei, and leukocytes generally prevail. Plasma cells are also more often seen than in the cornea.

Behind the affected area more numerous nuclei are seen than in the

balance of the cornea. The posterior surface of the cornea bulges somewhat toward the anterior chamber and shows undulations. These are due to wrinkling of Descemet's membrane which forms archlike projections into the chamber. There is no break in Descemet's membrane. These arch formations seem to be partly empty; partly they contain fine, granular coagulum staining pink with eosin, and partly some stratified tissue rich in nuclei, resembling the adjoining cornea.

Over the central part of the cornea, the endothelial cells are almost entirely missing; an occasional cell on the posterior surface of Descemet's membrane cannot positively be identified as such and resembles more a lymphoid cell. Only near the angles of the chamber do the endothelial cells form a continuous layer, but even here they are fewer than in the normal eye.

The anterior chamber is about 1 mm. deep in the center. The angle is perfectly free in most sections and the structures surrounding it are almost normal; in a few sections, a peripheral adhesion of the iris to the cornea, measuring about 0.4 mm., is seen. The anterior chamber contains only a slight amount of granular, pinkish-staining coagulum containing a few cells of lymphoid character.

A small focus of lymphoid cell infiltration is found in the iris root and a similar one near the sphincter. A small, broken-up posterior synechia exists in the pupillary margin. Ciliary body, choroid and the other structures show nothing of interest. There is no glaucomatous cup.

A search of the literature for cases of true granuloma of the cornea will have to exclude at the outset the formations of granuloma tissue as the result of tuberculosis and leprosy. These cases undoubtedly belong to a different class, as is already evidenced by the etiology. One cannot positively class with these cases Bock's reports of granuloma following parenchymatous keratitis, on account of our present view concerning syphilitic parenchymatous keratitis.

Types of granulomas. If we thus limit ourselves to the pure granulomas of the cornea, it is for practical reasons advisable to divide them into the following three groups:

1. Granuloma in the region of the cornea, the result of a prolapse of the iris following perforation; this might properly be called granuloma of the pseudocornea.

2. Granuloma of the cornea extending from the conjunctiva of the eyeball near the limbus after injuries, etc.; granuloma of the sclerocornea.

3. Granuloma of the cornea, developing away from the limbus and not the result of perforation; granuloma of the cornea proper.

It is evident that cases of the first group cannot be classed as granulomas of the cornea, but they are here considered for purely external reasons only. While not very frequent, they are more often to be observed than the other two forms of granuloma. In the second case, a superficial examination gave one the impression of a granuloma of this kind, as depicted by Parsons. In Blaskovics' case, to be mentioned later, this possibility was also considered. In this group belong the two cases of Sichel, his observations 205 and 206, since perforation of the cornea had occurred in both instances. The case of Schmidt-Rimpler was probably of the same kind. His patient, a young laborer, after getting lime in both eyes, had paracentesis done on the right cornea on account of hypopyon. After nine months the right cornea was entirely opaque, everywhere traversed by blood vessels and showing a thick button of granulation tissue.

Schaeche's case of a boy who developed panophthalmitis with perforation, after mortar injury six months before, also belongs here. Large, mushroom-like granulomas formed at the point of perforation.

The case represented by Pagenstecher and Genth on their Plate 12, Figures 3 and 5, may possibly be another example.

Lawson's case of a cicatrix horn growing from the cornea, seems to be an unusual form of granulation tissue formation developing after corneal perforation.

Of the granulomas belonging in groups 2 and 3 of the foregoing classifications, the textbooks make no mention whatsoever. The German *Encyclopedia* says: "As granulomas of the cornea some few reddish, soft tissue-granulations growing to pea size have been described which later became pedunculated and regressive and which developed after an ulcer, an injury, or a chronic inflammation."

The only other references to granuloma of the sclerocorneal type in the available American literature are found when Weeks, discussing granuloma pyogenicum of the lids, wonders whether the so-called granuloma of the cornea or of the sclerocorneal margin is not akin to it. This granuloma of the cornea has a tendency to recur, he says. He has examined two sclerocorneal tumors. In the same discussion, Jackson mentions a case of granuloma at the margin of the cornea, in existence six to eight weeks, having a purplish-red surface; the edges reminded one of an epithelioma, but were perfectly soft.

In the discussion of burns of the eyeball by lime, Lewin and Guillery mention the following cases in which the granuloma formation began in the conjunctiva of the eyeball and advanced onto the cornea. (1) The cornea of a mason's helper, after mortar had splashed into his left eye, became covered with granulation tissue, reaching from the

limbus almost to the center although no ulceration had developed.

(2) The case of Desmarres, of a mason whose cornea, after he had fallen into a lime pit, became covered with a sarcomatous growth.

(3) After getting lime into the right eye twenty-five days before, a boy showed mulberry excreescences on the swollen conjunctiva and the vascularized limbus. Two months later, the excreescences covered the whole cornea. After three months, only a small point of the cornea was clear and the remainder was covered by an enormous granulomatous mass pedunculated at the base. (4) Gosart's case of a fleshy pterygium which partially covered the cornea.

To this group also belongs, without doubt, the first case here recorded.

Beierle reports a case belonging in this group of hypertrophy of the conjunctiva and granuloma on the otherwise intact cornea of a dog. He assumes injury of the cornea.

The most interesting group is formed by those cases in which the granuloma unquestionably originated in the cornea itself, away from the limbus, and did not follow perforation—only resulting from a destruction of corneal tissue, with or without the formation of an ulcer. It is in these cases alone for which the term granuloma of the cornea should be reserved. Search of the available literature discloses only the following cases.

Blaskovics' patient, a woman, aged 25, had recurrent eye inflammation with photophobia when a child. When 8 years old, she received an injury to the right eye and a white spot in the center of the cornea resulted from it. Four years before she came under observation, a red area appeared in the center of the spot and increased gradually. When seen by Blaskovics, the tumor was 10 by 11 mm. in diameter, 1 mm. thick, yellowish-red and soft, its surface irregular. Granuloma from an iris prolapse was considered a possibility, but tumor of the cornea finally diagnosed. The examination of the enucleated eye revealed no bacteria. The cornea showed absence of the superficial layers in the center. The deeper layers were loosened. Near the growth the cornea was infiltrated with round cells and numerous vessels extended into it from the conjunctiva. Bowman's membrane was absent in the whole extent of the growth. A 1 mm. band of unaffected cornea extended all around the growth. It was divided by connective tissue septums, forming wide meshes. These contained homogeneous intercellular substance with small round cells, and the nuclei were often in mitosis. He considers it a case of typical granuloma of the cornea.

Blaskovics also quotes as true granuloma the three cases of Bock.

In his first publication Bock relates two cases of granuloma formation of the cornea among ninety-two cases of parenchymatous keratitis. The masses disappeared gradually and left dense opacities. His third case was that of a boy, aged 13, who had had parenchymatous keratitis of the right eye some time before and on whose left eye a growth developed during the four weeks previous to consultation. In the center of the opaque cornea, which showed deep vessels, a growth of 3 mm. was visible. It increased rapidly during the two weeks of observation and became constricted at the base. The excised growth showed the picture of a wound granuloma. Its pedicle was covered with one layer of epithelium. The condition is looked upon as the result of a circumscribed excessive accumulation of lymphoid cells which after breaking through the lamellæ in front of it, could grow unhindered. These cases are not mentioned in Lagrange's excellent work.

The case of Pagenstecher and Genth is an undoubted case of pure granuloma of the cornea proper, though some misunderstanding has been created in the literature about it, owing to the use of the word sarcoma in the English translation of the German text. Its granulomatous character is also maintained by Lagrange and by Gayet, whom he quotes.

The granuloma in Raabe's case developed at the seat of a healing septic ulcer of the cornea which had been cauterized. The histologic examination showed granulation tissue.

Hirschberg and Ginsberg describe a large, prominent, coccumb-like, grayish-red granulomatous tumor on the cornea of a girl of 9 having tuberculosis. The tumor showed granulation tissue with numerous leukocytes and areas of myxomatous tissue. It was not covered by epithelium.

A vascular pedunculated growth, developing rapidly after injury, was reported by Bargeton and thought to be possibly a sarcoma, but histologic examination confirmed the clinical diagnosis of botryomycosis. A similar diagnosis was made by Reihaus whose patient, a woman of 46, had much eye inflammation when a child, and whose left cornea showed a small, white tumor beginning at the lower margin and extending into the pupillary area. The histologic examination of the excised tumor revealed it to be possibly the product of proliferating inflammation and certain small bodies found are interpreted as "hefa." Axenfeld, reviewing these two cases, says, "There is no proof that any of the cases were any different from what have been described in the literature as granulomas. Further investigation is necessary to determine the pathogenesis of these growths."

Case 2 here reported agrees in all histologic essentials with the cases of Blaskovics, Bock, Pagenstecher and Genth, Raabe, Hirschberg and Ginsberg, etc., and is therefore, one of a pure granuloma of the cornea, of which histologic examination could be made.

Bajardi reports a pedunculated granuloma on the cornea of a rabbit, probably resulting from an ulcer. It was covered with epithelium. Gay found a pea-sized tumor on the cornea of a bitch, consisting of granulation tissue.

It does not seem quite certain that the case of Adler is really one of granuloma of the cornea although apparently classed as such by Lagrange. Strangely enough, this case does not seem to be reviewed in the contemporaneous German literature. A railroad employee, suffering from gradual diminution of sight with moderate local inflammation of the eyes for two years, showed gray, gelatinous granulations on each cornea, eighteen on the left and fewer on the right eye. The histologic examination revealed them to be a kind of miliary granuloma, consisting of corneal tissue covered by an epithelium much thicker than normal and suggesting those fibrous formations one sees especially on serous membrane following chronic inflammation. But in view of the peculiar histologic findings the bilateral arrangement, the multiplicity of the growth, and finally because of the occupation of the patient it might be pardonable to think that the condition of each cornea was nothing else than a kind of hypertrophy of the corneal epithelium, as seen at times after recurring irritation, produced in this case by repeated foreign body injuries.

A number of cases are recorded in the literature under different names, such as fibroma, myxoma, sarcoma, etc., in which the condition described can without undue force be explained as some result of granuloma formation of the cornea either showing greater development of fibrous tissue, or changes of a myxomatous nature, etc. Some of them are undoubtedly only changes in a pseudocornea following perforation or destruction of the cornea. As such may be classed the cases of H. Adler, Benson Cases 1 and 2, Capellini, Falchi, Gallenga, Mitvalsky, Polignani, Quaglino and Guaita, Rogman, Rumschewitsch, cases 1 and 2, Scott and Story, Silex, Simon, Szokalski, Zirm, etc. In this connection Parsons (264, 265) remarks: "No sharp line can be drawn between purely inflammatory conditions and many so-called growths As to the embryonic spindle-celled type of sarcoma, it may be doubted whether some of them are not simple granulomata (granulation tissue)." Similar opinions are voiced by Lagrange, Blaskovics and Wintersteiner.

It is difficult to say where Stellwag's case is to be placed. The his-

tologic examination, though quite insufficient for classification, is not of such a character as to exclude the possibility of a granulomatous origin.

Etiology. In connection with the question of etiology, one will have to consider two points: (1) Under what condition does granuloma arise in tissues and especially in the cornea? (2) Why did the destruction of corneal substance not lead to any secondary infection but only to the formation of granulomas?

On this point, Mallory says, "Healing by granulation is the repair of wounds where there is more or less loss of tissue which has to be filled in by new formation of cells. The injury is often excessive, and much foreign material has to be removed."

It is interesting how well this description applies to all cases of granuloma of the cornea in which a good history of the origin exists. Burns of the cornea by lime or other chemicals will be followed by necrosis and the necrotic material will have to be cast off before repair can be set in. The same thing will apply to destruction of the cornea by ulcers, vesicle formation, etc. If the corneal tissue has been destroyed by an inflammatory process, such as in parenchymatous keratitis, it need not lead to any loss of substance on the surface, resulting in an ulcer; the process of removal of the necrotic material and the details of repair will be essentially the same and may, therefore, lead to granuloma formation. It is more difficult to explain how these cases with their long standing necrotic ulceration escape secondary infection and rapid destruction of the remaining cornea. It may possibly have to be ascribed only to a fortunate circumstance that the ever present pathogenic microorganisms did not enter the tissues. After vascularization has taken place in the cornea, and even more so after the granulation tissue has begun to develop, the cornea becomes more proof against the attacks of bacteria. In this connection, it is interesting to remember the remarks of Weeks and Axenfeld quoted in the foregoing.

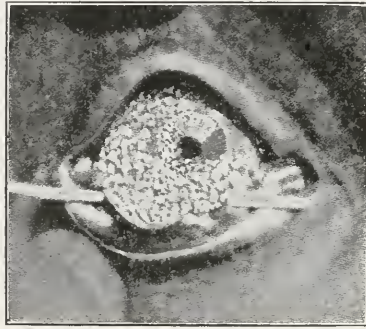
In the *treatment* of these cases, it will be well to bear in mind the continued danger of infection and therefore to limit one's self to as little manipulation as possible. Abscission of the granuloma may not be advisable, in view of the several reports of their recurrence, and especially so because such action may open an avenue for infection. It is best to await the absorption of the granuloma in consequence of the scar formation and the accompanying reduction of the blood supply. This plan was carried out in the first case reported.

Myxoma of the cornea is described on p. 3436, Vol. V of this *Encyclopedic*. As a polypoid growth it is mentioned as a condition charac-

terized by the appearance of a pedunculated tumor, smooth and red-dish and composed of irregular globular masses which sometimes appear after perforating ulcers of the cornea, or following suppurating keratitis.

Papilloma of the cornea. See p. 3427, Vol. V of this *Encyclopedia*.

Contino (*Oph. Year-Book*, p. 362, 1912) gives a detailed account of the clinical history and histology of eleven cases of *papilloma* of the limbus corneæ, since a similar study was published by the author in 1902. A review is also given of the literature of the subject during the same period, covering twelve additional cases. Two forms of papilloma are distinguished, a small one characterized by enormous



Papilloma of the Cornea. (Coover.)

proliferation of the epithelium, as compared with a scanty formation of connective tissue papillæ; and a large form in which the proliferation of connective tissue at least equals the epithelial growth. The first and more benign kind is the more frequent. It is sometimes triangular in shape and then is liable to be mistaken for pterygium or a large phlyctenule. It occurs as a fleshy exerescence of smooth surface and sharp outlines, usually opposite the palpebral fissure. The second type is rarer, has a mulberry appearance, and passes without sharp borders into the surrounding epithelium. It is more adherent than the first form. From his histologic studies the author decides that the limbus tumor originates from a hypertrophy of the epithelium, with reaction of the connective tissue and consequent enlargement of the small papillæ which normally occur in this region. Incidental causes are slight trauma and continued irritation of the eye. Of three cases of limbus papilloma reported by Rosenhauch, one is of interest because multiple growths appeared simultaneously in each eye; and another because, two months after

excision of a growth which had the typical histologic structure of papilloma, it was necessary to remove a recurrent mass which showed carcinomatous degeneration.

Perithelioma of the cornea. This rare formation will be considered in connection with *sarcoma of the cornea*.

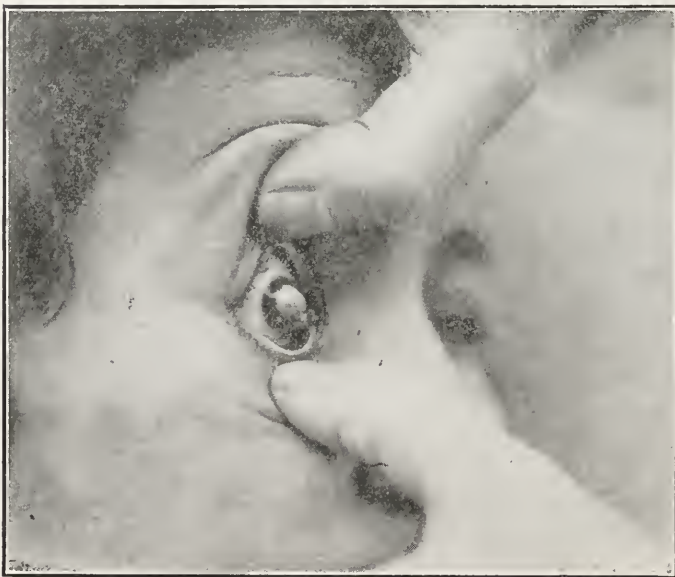
Sarcoma of the cornea is discussed on p. 3445, Vol. V, as well as on p. 11543, Vol. XV, of this *Encyclopedia*. To this may be added a reference to the paper of L. W. Dean (*Annals of Ophthalm.*, p. 764, Oct., 1913) who reports a case in a woman, aged 63, who noticed a brownish, flat growth on the cornea of the right eye, which had increased somewhat in thickness. There was no pain, but vision failed rapidly. The tumor apparently grew from the anterior surface, was of light-rust color, very vascular, 5 mm. in vertical and transverse diameters and the apex 2 mm. above the surface. It occupied the central portion of the upper half, extending a little below the median line, but having above 1 mm. of clear corneal tissue, traversed by numerous blood vessels. The tumor was enucleated April 26, 1912. Microscopically it was found to be a cellular mass of tissue, not covered by epithelium, but overlapped at the edges by the epithelium of the cornea. It was well defined from the corneal tissue, but there was nothing to suggest capsule formation. The corneal epithelium was absent beneath, but Bowman's membrane was intact except in the center, and the substantia propria at this point was slightly infiltrated by the tumor. The cells were large, round or oval, oat-shaped and some slightly spindle-shaped, with mitotic figures numerous, and a few cells containing finely granular, yellowish pigment suggesting melanotic sarcoma. Blood vessels were numerous and were surrounded by small lymphocytes. Collagen intercellular fibrils were shown by Van Gieson's and Mallory's stains; fibroglia fibrils were also present. Diagnosis, sarcoma, originating entirely from the cornea, probably from the superficial layers of the substantia propria.

Derrick T. Vail reported a case in which a diagnosis of *melanosarcoma of the cornea* had been made but Vail had diagnosed it as a *soft fibroma*. The anterior elastic membrane of the cornea was not invaded; it was a purely epithelial growth and seemed to spring from the usual site of a pterygium. It had extended entirely across the pupillary area and the pupil could only be seen by looking obliquely under the tumor mass, which was fungoid, dark in color and easily stripped from the cornea.

J. E. Colburn reported a case in which he removed what was supposed to be a pterygium from the inner canthus. In a few months it had returned and covered an area three times its original size. It



Congenital Tumor of the Cornea. (Stark.)

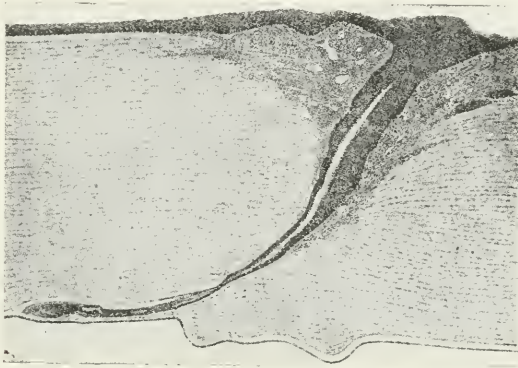


Tumor of the Cornea from the Side. (Stark.)

was removed again, and in about six months the patient had an irregular, swastika-shaped tumor over five-sixths of the entire cornea. It was determined after its first removal that it was a melanosarcoma. It was extirpated with a white-hot electric needle or curette, going over the entire surface of the cornea and burning it quite deeply. Recovery was uneventful and prompt. It was removed ten years ago, and the patient, a physician, was seen a few weeks ago, when the affected eye gave the better vision, and there was no scar on the cornea.

GROWTHS IN THE ANTERIOR CHAMBER.

Apart from *cysts* these are rare tumors. Urmetzer (*Oph. Year-Book*, p. 174, 1909) has written a paper, dealing with *epithelial cysts*



Section of Cornea Showing Epithelial Invasion of Corneal Wound. (Urmetzer.)

involving the anterior chamber. He recognizes (a) those due to congenital inclusion and abnormal development of epithelium; and the cysts following trauma through implantation, or more frequently through extension of the epithelium along the track of the wound. (b) Endothelial cysts which arise spontaneously, as from the closure of an iris crypt. (c) Pseudo-cysts, due to an inflammatory adhesion of the iris to the cornea or the lens. In two of his cases following perforating wound and ring abscess of the cornea, the epithelium extended from the corneal surface to the cyst. In three cases, following injury, buds or pearls of epithelium had invaded the corneal substance. He finds that the epithelium may creep into the anterior chamber, and line it more or less completely, causing glaucoma, without any cyst being visible. The extending epithelium may reach the equator, and even the posterior surface of the lens.

Gradle also reports two *cysts of the anterior chamber* following in-

jury, in one of which eight years elapsed before the cyst began to give trouble. Both cases were relieved by iridectomy and removal of cyst wall. Thilliez proposes treatment of these cysts by electrolysis instead of puncture, which is usually followed by recurrence, or by ablation, which is sometimes difficult. In a case reported, he introduced a platinum needle, connected with the positive pole, into the cyst, and passed a current for two minutes of one milliampere, and later for a similar time, 2 milliamperes. The treatment was easy and inoffensive, and there had been no recurrence in five months.

Another instance of *unattached cyst in the anterior chamber* is reported by Coats. The cyst floated free, its position varying with that of the patient. Its walls contained brown pigment, and there was also a powdery deposit of pigment on the lens capsule, as well as some very delicate superficial opacities in the lens. The eye was otherwise normal. See, also, **Cyst in the anterior chamber**, p. 3673, Vol. V of this *Encyclopedia*.

TUMORS OF THE IRIS.

These neoplasms have already been discussed under various headings in this *Encyclopedia*; especially under **Iris, Tumors of the**, p. 6641, Vol. IX. Many iridic neoplasms are there described; as well as under other **Iris** headings. See, also, **Cyst of the iris**, p. 3674, Vol. V; and **Sarcoma of the iris** on p. 6643, Vol. IX and p. 11545, Vol. XV. To these observations are here furnished some additional notes.

Cyst of the iris. In addition to the matter to be found on p. 3674, Vol. V of this *Encyclopedia*, attention is directed to the paper of Nadal (*Oph. Year-Book*, p. 363, 1912) and others. From the left eye of a boy of 11 years Nadal removed a congenital cyst of the iris measuring 6 by 8 mm. The fact that the cyst was lined by epithelial cells is in conflict with the suggestion of Schmidt-Rimpler, that such congenital cysts are due to closure of one of the crypts of the iris. In Pisani's case, the cyst had pushed the iris inwards, producing an iridialysis. There was no history or indication of accidental or surgical trauma in either this case or that of Jänner. The latter's case, however, resembles one published by Tschentzoff in that there was a history of inflammation having occurred in the eye some years previously. A boy of 4 years, seen by Ginsberg and Cohn, had had a severe inflammation in the right eye following an attack of measles at the age of one year, and an iridectomy had evidently been performed. There was a rapidly-developing, yellowish-red growth at the angle of the anterior chamber, and in relation with the iris coloboma; and

on enucleation of the blind eye the tumor proved to be a cyst in the anterior layers of the iris, containing large numbers of needle-shaped crystals which gave the reactions of a fatty acid.

To avoid the risks attending radical operation on iris cysts, Schoeler proposes to inject them with a very small quantity of diluted tincture of iodine. After use of a miotic to protect the lens capsule, a hypodermic syringe needle is passed from the limbus into the cyst without entering the anterior chamber. When the cyst has emptied itself through the needle, the few drops of diluted tincture are injected. Scrupulous care is required to avoid introducing any of the tincture into the aqueous, because of the risk of causing opacity of the lens capsule in cases where the lens is intact. This accident occurred in the second of the two cases reported by the author.

The right eye of a boy, aged 7, observed by Böhm (*Oph. Year-Book*, p. 155, 1916), showed slight injection, cornea clear, anterior chamber in its inferior temporal portion abolished, otherwise shallow; the pupil did not react. The *iris was not clearly delineated and showed a cyst* in its lower temporal portion, translucent, filled with fluid and lying close to the posterior surface of the cornea. As there was no perception of light and the eye glaucomatous, it was enucleated. Microscopically, the cyst, of unknown etiology, lay in the mesodermal part of the iris, the stroma itself, from which it had started, and filled the whole anterior chamber from the lens to the cornea. The pupillary margin and the root of the iris did not participate. The optic nerve showed a distinct pathologic excavation. The lens was indented in consequence of the growth of the cyst. The cyst contained cast off epithelial cells, cell detritus and a homogeneous exudate. Böhm attributed the development of the cyst, according to the theory of Juselius, to remnants of the ectoderm, which during the embryonic period was not wholly transformed into muscles of the iris. The sphincter at the side of the cyst had remained rudimentary. Also on the normal side it was interrupted by septa of connective tissue. The anterior wall of the cyst was very thin and consisted solely of an epithelial layer, adherent to Descemet's membrane. The iris tissue was destroyed, probably from atrophy by pressure.

Bailey presented a girl, aged 16, whose one cornea was injured, eight years ago, by a penetrating wound in the upper nasal quadrant for a distance of one-eighth of an inch, incapacitating her for a week. Three weeks before an ear of corn was thrown against this eye and caused pain. There was a nonpigmented and absolutely translucent growth in the anterior chamber which almost filled the entire pupil-

lary area. After dilatation of the pupil by homatropin Bailey noticed also a pigmented tumor in the posterior chamber a little lower down toward the nasal side. This might have been malignant because of the pigmentation. Dodd, in discussion, related a case of cyst of the iris which developed after the removal of traumatic cataract. It was multilocular, filling one-half of the anterior chamber. He made an incision and removed as much of the cyst wall as he could.

At the March, 1919 meeting of the Coll. of Physicians, Philadelphia the following case was presented: J. M., male, aged twenty years. Seen at Wills Hospital February 28, 1919. He came on account of attacks of blindness in the right eye. The first attack was in June, 1917, while caulking. Vision was reduced to p. l., and this state lasted a couple of days. Vision recovered completely, but halos have persisted. No pain. Between this time and February, 1919, the interval of attacks was about six months. Since the latter date they have been almost constant, there being but slight intermissions. Family history negative. A "spot" had been noticed in the R. E. since early childhood. Vision R. E., 6/9 pt.; L. E., 6/6 pt. Tension R. E., 30 mm.; L. E., 20 mm. Field, R. E., slight irregular contraction, with a reentering angle below.

R. E. Iris light-hazel. Cyst, chocolate-brown. Mass is 4.5 mm. by 3.5 mm. and fills the angle of the chamber from the outer border of the sphincter to the ciliary border. It is dome-shaped with the convexity above. The borders are rounded and cast a shadow on the iris. The surface is smooth except for a slight thickening of its anterior surface near its base.

The larger circle of the iris is greenish-gray in temporal segment but is hazel in its nasal half. The anterior chamber is deep; the iris reacts well to light. The fundus is normal.

Under the use of pilocarpin, vision has increased to 6/6 minus, and T. = 22 mm. of Hg.

This case belongs to the *idiopathic type of iris cysts*. The pathogenesis is obscure, but they have been explained as arising from a blocking of an iris crypt. Some sort of surgical interference is indicated. Either the surface of the cyst wall may be excised or an iridectomy including the growth should be done. The latter would seem to be the surer operation.

Glioma of the iris is the name given by Weekers to a growth found in the eye of a girl three and one-half years old. When one year old the parents noticed the right pupil different from the left, and for the last three weeks a "little skin" had appeared on the right eye. There was no inflammation, but the ciliary veins were large, and

the cornea a little clouded. The iris was thickened, adherent to the lens capsule, and thrown into folded masses, reddish-yellow in color. Six months later the eye had become painful, with ciliary injection and new-formed vessels in the cornea. An injection of one milligram of old tuberculin produced a general, but no local, reaction. After enucleation, the mass filling the anterior chamber was found to have pushed back the lens to the middle of the eyeball, and quite replaced the ciliary body. It presented the typical structure of glioma with necrotic areas. Weekers mentions previously reported cases of this kind, including one of Badal and Lagrange, published as a primary sarcoma of the ciliary body.

Hemangioma of the iris. A rust-colored tumor of the iris was accidentally discovered by Hönig (*Oph. Year-Book*, 1912) in a man of 47 years. After study with the Czapsky corneal microscope, the growth was diagnosed as *hemangioma*, consisting of an enormous dilation of the capillary vessels of the iris stroma. There was apparently a slight increase in size during two months' observation.

Myoma of the iris. This excessively rare tumor is described by Van Duyse and Baiy (*Oph. Year-Book*, 1912) who removed a tumor of the lower outer quadrant of the iris, which had been present for twenty-one years and had been the source of repeated hemorrhages into the anterior chamber. Microscopic examination showed the base of the tumor to be composed of smooth muscle fibers, while its superficial part was of the nature of spindle-cell sarcoma. It was therefore diagnosed as *leiomyoma sarcomatodes*.

Melanoma of the iris. An instance of this rare growth is reported by Woodruff (*Oph. Year-Book*, 1909). The patient, a woman aged 22, had noticed a black streak in the lower nasal quadrant of the iris for 2 years, but in the last three months it had increased considerably in size. From this fact it was judged probably malignant. In a case reported by Groenouw, a brown tumor 6 mm. by 3 mm. existed in the iris of a man aged 41. Notes made at the time showed that it had the same dimensions 22 years before. But in the last 5 years the eye had gradually become blind without inflammatory symptoms. Groenouw thinks probably a melanoma had gradually become sarcomatous.

Chevallereau reports a gray tumor of the iris 3 mm. in diameter, which was said to have existed 7 years without change. When first seen tension, vision and field were normal. But there were a few floating vitreous opacities. A few months later severe pain, hyperemia and increased tension supervened, apparently with hemorrhage. Tuberculosis was suspected but not shown by tests.

Sarcoma of the iris. In addition to the matter on p. 6643, Vol. IX

and p. 11545, Vol. XV of this *Encyclopedia* the reader is referred to the paper of Wintersteiner (Abst. in *Year-Book*, p. 316, 1909) on *iris sarcoma and iris endothelioma*; in which a tumor of the iris was removed by iridectomy; and almost 9 years later there was no trace of recurrence, and the vision of the eye was 6/10. He also brings together 9 previously reported cases of leucosarcoma, and points out that the majority of unpigmented sarcomas and endotheliomas have occurred in childhood or early youth. He discusses the question of treatment, concluding that the normal operation for iris sarcoma is enucleation of the eyeball; but that iridectomy is proper for a few cases, where the growth is small, circumscribed, solitary, and situated in the pupillary portion of the iris. Judin reports a case of spindle-celled sarcoma removed by iridectomy. The keratome incision was too short, requiring to be extended with the scissors. Eight days after the operation optic neuritis occurred; still, vision of 9/10 was regained. Offret reports a case of spindle-celled sarcoma arising on the posterior surface of the iris, in a woman aged 72.

A man of 49 years, from whose right eye Stephenson removed a melanotic sarcoma of the iris, was quite unaware of any unusual appearance of the eye, and merely complained of some slight discomfort in reading. An oval area of chocolate-brown color, 1.5 to 2 mm. long, occupied the lower nasal part of the iris periphery. Several small pigmented spots were present on other parts of the iris. On full dilatation with homatropin and cocain, the pupil was flattened in the vicinity of the growth, which had a convex appearance. Sections of the enucleated eyeball showed the root of the iris at its lower nasal quadrant to be replaced by a fusiform swelling, the cells of which were very heavily pigmented. Some of the ciliary processes were invaded. The presence in the sections of several pigmented moles suggested that the growth had originally developed from one of these.

Alt's specimen of partly pigmented spindle-cell sarcoma of the iris involved the whole periphery of the iris. The eye also showed a localized proliferating choroiditis and a microscopic hole in the fovea. The peculiar feature of Lattorff's iris sarcoma was that it had existed for thirty years. Thorington reports a case of small round-cell leukosarcoma, occurring on a blue iris and successfully removed by iridectomy. A tumor of which an elaborate study was made by Del Monte had begun as an angiosarcoma, but in its newer portion had taken on a purely sarcomatous character. It originated independently from both the iris and ciliary body. The peculiar transformation in its structure appears to the author to confirm the contention

of Fuchs and others, that uveal sarcoma arises from the blood vessels more commonly than is ordinarily believed.

Raubitschek (*Klin. Monatsbl. f. Augenheilk.*, May, 1914) describes in detail three tumors of the iris. The first consisted of an unpigmented part of the character of a spindle-cell sarcoma, resembling an endothelioma, with only a very few pigment cells, and of a tissue consisting of multiform, richly pigmented elements. It was a connective tissue tumor, calling to mind in its unpigmented layers endothelioma of the iris. Raubitschek does not put himself on record as to whether he considers this a tumor of mixed endothelioma and melanosarcoma tissue or whether we have here an illustration of Ribbert and Schieck's theory that the melanosarcoma develops from chromatophores by way of an intermediary unpigmented form. The second and third cases were granulation tumors in which all etiologic factors gave negative results on investigation.

Laven (*Klin. Monatsbl. f. Augenheilk.*, Oct., 1913) remarks that according to figures compiled by Fuchs, primary sarcoma of the iris occurs but rarely—once in twenty-five thousand cases of eye disease. In Hirschberg's clinic only one case was found amongst 83,000 patients. Laven's patient was a twelve-year-old girl of good general health. A pigmented nevus of the right, grayish-blue iris had been present for several years. Sudden growth of the nevus, especially anteriorly, led to rise of tension, and besides small masses of pigment began to appear at various points on the surface of the iris. Enucleation was promptly done, and one and a half years later no demonstrable or suspected metastasis had appeared. The majority (seventy-six of one hundred and two cases) of sarcomata of the iris had appeared in persons past thirty years. Although most iris sarcomata are melanosarcomata, their development is slow as compared with similar tumors in other parts of the body. Six cases of death from general sarcomatosis following sarcoma of the iris were on record up to the time of this report. While local recurrences are less likely after enucleation than after iridectomy, metastases in distant organs do occur even after the radical procedure. That in certain cases the excision of the growth is ample treatment is proven by two cases, in whom, eighteen years after iridectomy, no recurrence had been noted.

The *Ophthalmic Year-Book* for 1916 reviews a number of these cases. A diagnosis of sarcoma of the iris with very probable encroachment on the ciliary body was made in Irwin's case. A man, aged 40 years, with a pigmented growth was observed for six months without the tumor causing any symptoms. The consensus of opinion of all who examined the case affirmed that prompt enucleation offered the

surest prevention of metastasis. In the discussion Tyson referred to a case of his own, where the patient was still alive and well ten years after operation.

Stephenson reports a case of *cyst of the pigment epithelium of the iris* obtained from a lady, aged 43 years, in which there was raised the question of *sarcoma*. Projecting from behind the pupillary edge of the lower temporal segment of the iris was a single smooth, rounded mass of dark-brown color, 3 mm. by 2 mm. The mass showed up as a dark projection when the eye was illuminated by the Leber instrument. Under the belief that the growth was a melanotic sarcoma, the eye was removed. Pathologic examination revealed a congery of several small cysts with a much larger one, all formed by a separation of the uveal layers with fluid. The interior showed no formed elements beyond tiny particles of melanin.

Wallace details the history of a very rare case of tumor in a child aged 14 months. At birth the mother noticed a pin-sized tumor of red color in the lower-inner segment of the right anterior chamber. There was also a second small tumor of the angle of the right maxilla. At the time of observation the mass filled that portion of the anterior chamber, from the inner axis 165 degrees to 75 degrees, with an attachment which seemed to be in the angle. Its size was approximately 8 mm. by 6 mm. The entire posterior surface was in apposition with the iris and lens, the anterior surface being in contact with the posterior surface of the cornea. The eyeball was not enlarged. The soft mushy tumor was removed piecemeal through the incision at the limbus. The lens and iris appeared in good condition. Heller reported his pathologic findings to be an endothelioma. The neck tumor was thyroid gland. Wallace did not see that any pathological connection could be possible between the eye tumor and the thyroid tumor. There being no microscopic examination of the latter this cannot be verified or controverted.

O. Berner (*Norsk Magazin for Laegevidenskaben*, v. 79. No. 12, 1918) presents the clinical and microscopic findings of a case of *sarcoma of the iris* and gives his theories as to the development of these tumors. The patient was a woman of 37 years of age who presented herself on account of a sudden dimness of the vision of the left eye which, however, had disappeared over night. The writer explains this symptom by supposing a possible hemorrhage from the tumor into the anterior chamber.

Clinical examination showed a lens-shaped, almost round elevation of the iris of about 2.5 mm. diameter at the pupillary margin below in the left eye. It was heavily pigmented, dark-brown, while the

general color of the iris was bluish-gray. The iris had besides small brown spots throughout. The patient stated that she had always had a brown spot below the pupil. No vascularization could be made out even with a strong loupe, nor could any adhesions to the lens be found. Transillumination of the ciliary region was negative. There was no conjunctival injection, media clear, fundus negative, and no increase in tension.

A complete iridectomy downward was done. The microscopic picture showed a marked cellular proliferation in the stroma of the iris, especially at the pupillary edge, characterized by small, dark, even-sized spindle-shaped nuclei. A few sections showed typical giant cells, but in none could any polynuclear leucocytes be found. Pigment cells of two types were very numerous in some sections, the first type a large round-cell so heavily pigmented that the nucleus was obscured, the other a smaller cell with a variable amount of pigment. By using Alfieri's method of removing the pigment a differentiation between the retinal and stroma pigment cells was obtained. The author also convinced himself of the presence of "klumpzellen" in the stroma. All in all the microscopic appearance reminded one very much of Casey Wood's and Brown Pusey's case.

The author discusses at some length the theories as to development of sarcoma of the iris. Other writers have traced a relationship between the pigmented spots of the iris and sarcoma. It has been pointed out that these pigmented spots are separate and distinct from the regular coloring of the iris. In structure these pigment spots consist of so-called "klumpzellen," large round cells very heavily pigmented; and differ markedly from the small pigment cells of stroma of the iris. He believes that these "klumpzellen" are really retinal cells detached during embryonic growth and pushed into the stroma layer.

In support of this theory he points out that these cells are most numerous in the posterior region of the iris and also at the pupillary border, at which latter place he assumes they are detached at the same time as the retinal cells which go to form the muscle of the sphincter of the pupil. The stroma cells are of mesodermic, while the retinal are of ectodermic origin.

TUMORS OF THE CILIARY BODY.

In any form these are very rare neoplasms. They are fully described on p. 2230, Vol. III of this *Encyclopedia*, while examples are added here.

The *Oph. Year-Book* for 1909 is the source of several of the following references.

The tumors arising from the ciliary epithelium have been systematically discussed in a paper by Fuchs. Simple outgrowth due to senile or inflammatory proliferation may form local thickenings or club-shaped projections, or even cystic swellings. The *benign tumors* occur in elderly persons and give no clinical evidence of their presence, being usually not over one millimeter in diameter. They differ from true adenomas in the absence of stroma and in the direction of their growth. The *malignant tumors* Fuchs divides into two classes. Those having the structure of embryonic retina have been called carcinoma, teratoneuroma, epithelioma, glioma, etc. He proposes to designate them as diktyoma. The second class are tumors in the structure of which only the ciliary epithelium is represented. Some of these are cellular membranes combined with cellular tubes; others show tubes alone; and others irregular groups of cells with a few tubular formations in the youngest parts.

In a case of *sarcoma* described by Verhoeff, although what seemed to be the primary growth in the ciliary region measured only 3.5 mm. in the greatest diameter, metastases had occurred both within and outside the eyeball. Secondary glaucoma, which brought the patient for enucleation of the eye, had arisen from the deposit of the tumor cells in the filtration angle. A clinical case of probable sarcoma of the ciliary body was demonstrated by Crampton. A growth was seen through the pupil by oblique illumination, and the root of the iris was dragged backward.

Adenoma of the ciliary body has been described by Fuchs, Pergens and Alt. Of this condition, Parsons (*Pathology of the Eye*, Vol. 1, page 164) states "The published cases of adenoma are too few and too anomalous to admit of dogmatic statements. The diagnosis of an adenoma presupposes the existence of glands and this question must be regarded "subjudice." On the other hand, looked at from a point of view of inflammatory or degenerative hyperplasia (Emmanuel Kruckman), there is no such theoretical foundation, whilst it must at the same time be admitted that simple hyperplasia does not usually assume such an atypical complexity of structure.

A. J. Brückner (*Archives of Ophthalmology*, Sept., 1915) has reported a *fibroadenoma of the ciliary body*. The patient, sixty-three years of age, noticed six years previously a small enlargement of the skin at the inner canthus of the left eye. It increased rapidly in size and was burned away by a physician. Recurrence took place, and a

sloughing cavity, apparently involving the eye, developed. The eye was removed by enucleation.

Microscopically there was seen in the anterior portion of the ciliary body a small tumor mass not over 0.75 millimeter in diameter, which the writer calls a fibroadenoma of the ciliary body.

The tumor mass itself consisted of a sharply-defined body made up of aggregations of epithelium cells imbedded in an abundant homogeneous, vacuolated substance.

Shine reported a *cyst of the ciliary body* in a woman, aged 44, who never had an eye trouble until two months previously when she accidentally discovered that she could not see out of the right eye, except hand movements. Lens cataractous and tilted on its vertical axis so that the iris on its temporal side was displaced forward. Nasally, just behind the iris, was what appeared at first to be a pigmented growth, but on dilating the pupil and on transillumination there was found to be a more or less translucent body of regular contour, showing several parallel ridges or elevations. The root of the iris at this point was atrophic. Roentgen ray negative. Tension normal.

Heman H. Brown (*Journ. Oph. and Otolaryng*, April, 1916) reported an *osteoma of the ciliary body*. The patient, a girl, aged 18 years and 4 months; only child; family history so far as could be determined was good. No evidence of eye disease in either parents or parent's families. No trace of tubercular trouble with patient or families. Aside from the eye difficulty, the patient seemed perfectly normal in every way. Except measles, there had been no physical illness during her entire life. Her birth was normal (no instrumental delivery), and at birth the child in every way seemed physically normal. At four months of age the right eye became very red and inflamed, causing great suffering. The attack of inflammation lasted for two months, during which time she was under the care and treatment of a competent ophthalmologist, who pronounced the case glioma of the retina, and advised the removal of the eye. The inflammation, however, slowly subsided and the eye assumed a state of quiet, but the pupil remained widely dilated and fixed, with a distinct yellow reflex. This dilatation remained a permanent feature of the eye. (The mother thinks the eye was blind after the first attack, but previous to that time had noticed nothing to attract attention to the eye.)

Three months later the patient suffered a second attack of inflammation similar in its manifestations to the first though shorter in duration. Glioma was again diagnosed and enucleation advised. The diagnosis was concurred in by a consultant at that time.

Following this seizure the eye assumed a slightly staring appear-

ance. No further difficulty was experienced until at five years of age, when she suffered another attack of inflammation. This was the most severe of all, and the ophthalmologist in attendance again advised enucleation to avoid, as he stated, rupture of the eye-ball. There was no evidence at hand of irritation or disturbance of the left eye at any time. Aside from an occasional redness of the right eye, with little suffering, there was no further trouble for three weeks previous to the time she consulted Brown. At that time the following conditions were present: Left eye: Vision, 20/20; normal in every way. Right eye: light perception only, and in a state of general inflammation. This condition, she stated, had existed for three weeks. The cornea was slightly steamy in appearance, with bulging at the nasal side and noticeably thinner. Springing immediately from the limbus, there existed a wedge-shaped abrasion of the cornea, at its base four millimeters in width. This extended directly across the center of the cornea to the limbus on the temple side. Above and below the apex of this abraded area an imperfect view of the eye chambers could be had. The pericorneal injection was deep, indicating a marked ciliary inflammation. The sclera likewise deeply injected. The anterior chamber was deepened and iris out of sight. Aqueous and lens slightly turbid. Although the media could be imperfectly viewed, yet the yellow reflex from the posterior chamber could be seen quite distinctly. The motion of the eye ball was entirely unimpaired, but the upper lid was edematous and drooping. The suffering to the patient was excruciating. The history of the case and its present physical findings suggested but one course to follow, namely, enucleation, which was done under a general anesthetic on September 9, 1915. When under the anesthetic a hard tumor could be distinctly felt within the eye chamber, apparently smooth in its outline. The eye, after enucleation, presented nothing of particular interest. There were no adhesions to the orbital contents or marks of cicatricial contraction in the sclera, as might be expected after a traumatism.

The pathologist designated the tumor as a form of coloboma with a fetal inclusion of bony tissue.

In conclusion, Brown called attention to three points of interest: 1. The quite evident fetal origin of the tumor. 2. The confusion which may arise from diagnosis of tumors of the new-born eye. 3. The entire bone formation would seem to have confined itself to the ciliary body.

Adolph Gehrmann said that in this specimen one sees bone growth which is perfectly quiet. There is no evidence of any new growth or retrogression of the bone. The tumor is absolutely benign. As to bone

formation after injuries, there is one statement in the literature that bone may be found in the lens. The formation of bone after injuries occurs about as bone develops after injuries elsewhere when there are persistent inflammatory or circulatory changes.

There are three theories as to how and when this growth occurs as a metaplasia. First: Cohnheim's theory of fetal inclusion of embryonic cells. Second, bone formation on account of changes in the blood vessel walls, the protoplasm laying down bone itself. Third, the bone theory of Ribbet that bone cells are detached, float through the circulation and lodge at various points and form new bone structures.

A rare case of *malignant tumor of the ciliary body* is reported by Greeves. The patient was a girl of 10 years. The symptoms were loss of vision and appearance of the tumor through an iridodialysis. The tumor was grayish and about the size of a split pea. Microscopically it was made up of large cells, usually columnar; each cell having an oval nucleus parallel with its long axis, and lying nearer one end than the other in those cells which were definitely columnar. The cells were arranged in regular rows, two rows usually lying parallel and in contact. A lumen was nowhere distinguishable, the growth differing in this respect from two similar tumors previously reported by Treacher Collins. In places there was a circular arrangement of the cells somewhat like the rosettes of a glioma. The cells of the growth closely resembled those of the unpigmented layer of the pars ciliaris retinæ, with which the tumor was continuous, and from which therefore it was probably derived.

The ring sarcoma reported by Alling and studied pathologically by Knapp occupied the whole region of the ciliary body, extended back into the anterior choroid, and in one direction reached almost to the optic nerve. At three points it had penetrated the sclera and appeared upon the surface of the eye. It was heavily pigmented, but unusually free from blood vessels. In the case described by Reis (*Zeitschr. f. Augenheilk.*, p. 426, 1912), which also showed upon the surface of the globe, not only was an attempt at cure with radium unsuccessful, but the tumor manifestly increased in size. The author thinks it a mistake to waste time on the use of either radium or *x-ray* in such cases, unless radical removal of the tumor by enucleation is no longer possible. Ischreyt's specimen of ring sarcoma of the ciliary body was an alveolar growth, composed of epitheloid round cells.

The *sarcoma of the ciliary body* studied by Coats was remarkable for its local metastases. The tumor proper was deeply but irregularly pigmented, and composed of cells mostly polygonal. The surrounding tissue spaces were invaded for a considerable distance by

isolated tumor cells, and there were deposits of tumor cells on the back of the cornea and the surface of the iris. A small spindle-cell sarcoma for which enucleation was done by Coover, had completely destroyed the ciliary body and root of the iris in the region of its development. In a case in which enucleation was absolutely declined, Zirm removed a sarcoma of the ciliary region as thoroughly as possible through a T-shaped scleral incision. Although all sight was lost, the patient wrote two months later that the eye was free from pain and looked "perfectly natural." Knapp reports enucleation of an eye for supposed sarcoma of the ciliary body; the eye containing no tumor, but a retinal detachment with cystic degeneration which had probably simulated tumor behind the iris.

The *Oph. Year-Book* for 1913 also refers to the case-report by Akatsuka. A sarcoma of the ciliary body extended through the pupil into the anterior chamber, instead of in the classical fashion past the root of the iris at the angle of the chamber. Before enucleation the case was seen by Fuchs, who diagnosed the tumor as originating in the retinal epithelium of the iris or ciliary body. Hertel demonstrated specimens from a ring sarcoma of the uveal tract, which had diffusely infiltrated the ciliary body, the iris, and the choroid. The ciliary processes were but little infiltrated, and were completely covered by their epithelium. The relative preservation of the normal gross anatomy of the uveal tract rendered the diagnosis difficult. Transillumination with the Sachs lamp furnished no indication of tumor formation, and the diagnosis was only made after microscopic examination of a piece of iris, which had been excised for relief of glaucomatous symptoms.

Meller's case of epithelial tumor of the ciliary body, like the one reported by Fuchs, had developed apparently on the basis of chronic inflammation. The eye had been blind for many years, the probable nature of the original lesion being perforating ulcer of the cornea. It was enucleated for cosmetic reasons. Although there were some points of difference between Meller's tumor and that reported by Fuchs, the former summarizes the histologic characteristics of his specimen by quoting the words used by Fuchs in regard to the earlier case: "Its basic elements are epithelial cells grouped together without an intervening reticulum of connective tissue, probably in the first place as simple cubic or cylindric epithelium, and only later and with further growth, acquiring a more irregular arrangement." In places where the tumor had taken on a freer growth, as for example in the vitreous, a connective tissue stroma had developed.

Higbee's (*Oph. Year-Book*, p. 321, 1916) patient, a woman, aged 54

years, gave a history of having both eyes operated on at the same time for cataract 18 years previously. She could not see any better after these operations, the right eye becoming very much inflamed with a total loss of vision. Present examination of the left eye revealed a yellow tumor 5 mm. by 7 mm. attached to the corneal margin and extending back over the ciliary body, filling nearly the entire anterior chamber. Fully three-fourths of the mass was removed. A plus 10 D. sph. gave a vision of 20/50. Alt's examination of the specimen showed the mass to be composed of lens fibers, a number of foci of round-cell infiltration, and a large amount of cholesterin. This latter substance probably produced the straw-yellow color; Alt stating, however, it was new to him.

TUMORS OF THE CHOROID.

The attention of the reader is especially directed to p. 2167, Vol. IV of this *Encyclopedia* where, under the caption, **Choroid, Tumors of the**, these neoplasms are extensively discussed and illustrated. The literature of the subject to 1913 is also fairly well considered, to be continued in this sub-section.

Choroidal angioma. S. Hagen (*Norsk Mag. f. Lægevid.*, July, 1915) records an instance of this tumor in a seventeen-year-old patient who suffered with a congenital skin angioma covering the greater part of the face, and extending to the buccal mucosa and the conjunctiva. The patient had been practically blind in the right eye since early infancy. The sight of the left eye had always been good until four months before the patient came to the hospital, but for this period the sight of this eye had also been affected, the disturbance of vision being accompanied by pains and by the appearance of colored halos around lights. Ophthalmoscopically there was found at the posterior pole of the right eye a tumor-like protrusion of glistening, whitish-green color, and the tension of the eye was somewhat raised. The left eye presented an advanced glaucoma simplex. Upon an attempt being made to perform a hypotensive operation on the right eye, an intra-ocular hemorrhage occurred, which made removal of the eye necessary fourteen days later. Microscopic examination showed the growth to be an angioma of the choroid. The patient did not come to the physician on account of the poor vision of the right eye, in which the tumor existed, but because of the rapidly advancing glaucoma in the previously healthy left eye. The tension was higher in the eye in which no tumor was found. It is suggested that the rise of tension in both eyes may have been due to anatomic anomalies of the vascular system.

Salus (*Oph. Year-Book*, p. 324, 1913) compares the ophthalmoscopic and microscopic findings in a case of *angioma of the choroid*, occurring in a woman of 20 years. He finds his own specimen, and those of other writers, to be characterized by: 1. Extreme cystoid degeneration of the retina, principally limited to the region of the tumor, so that the surrounding retina may remain almost or entirely normal and free from loss of function. 2. Limitation of retinal detachment to the region of the tumor, and extremely slow increase of the detachment. 3. The occurrence of adhesions between the external retinal layers and the underlying tissues, without any symptoms of inflammatory processes. 4. The development of a more or less dense and vigorous connective tissue or epithelial layer, which limits the tumor toward the interior of the eye.

To the year 1914 only nineteen examples of this neoplasm had been reported. None of these was clinically diagnosed. Ischreyt (*Arch. f. Augenheilk.*, Vol. 77, p. 295) describes the tumor in a boy, aged 17, in feeble health. His right eye was always blind but not painful. For the last three weeks he had headache, lachrymation and photophobia. The anterior chamber was abolished, iris atrophic, pupil dilated; there were also intense pericorneal injection and increased tension, fundus not visible. The enucleated eye was hardened in alcohol. Meridional sections showed a flat tumor at the site of the choroid, whose greatest thickness near the posterior pole was from 1 to 1.45 mm. It consisted of a convolution of bloodvessels of different sizes, lined with endothelium and separated by septa, in other words, capillaries expanded into cavernæ. The angioma originated in the exterior layers of the choroid, which was penetrated by capillaries growing in various directions.

Angioma of the choroid is a congenital disease. It is either present at birth or a congenital predisposition leads to its development in later life. It causes marked alterations of all parts of the eye in consequence of disturbances of circulation and nutrition. Ischreyt found thickening of the choroid, drusen of the hyaloid membrane, and ossification. Two small osseous foci clearly indicated as their place of origin the choriocapillaris. The nutrition of the eyeball is often interfered with to such an extent that it atrophies. In all reported cases the visual organ was totally destroyed.

Salus (*Zeitschrift für Augenheilkunde*, October, 1913) gives a minute account of the histology of a case of choroidal angioma, and reviews the literature of the subject. The chief characteristics of these tumors are.—First, well-developed cystoid degeneration of the retina in the neighborhood of the tumor; the rest of the retina re-

maintaining normal and functional. Secondly, the detachment of the retina is confined to the region occupied by the tumor, and spreads very slowly; from the nature of the growth the exact opposite would be anticipated. Thirdly, the appearance of adhesions between the outer layers of the retina and the deeper layers, without any sign of inflammatory reaction. Fourthly, the appearance of a dense membrane of connective tissue or epithelial cells, which separates the tumor from the interior of the eye.

Treacher Collins and Leslie Paton (*Am. Journ. of Ophthalm.*, p. 437, June, 1919) report a case of angioma of the choroid. The patient, a boy, first came in 1917, when he was 14 years of age. There was a large nevus on the left cheek and outer side of left orbit. There was detachment of retina outwards and downwards. The tension of the eye was then normal. Puncture of the sclera was made with the galvanocautery, but the vision did not improve. A year later an acute attack of glaucoma occurred, and the eye was removed. There was found to be a lens-shaped mass in the choroid, measuring 9 mm. in length, 5 mm. in breadth, extending from the upper margin of the optic disc to a little behind the equator. There were the typical appearances of cavernous angioma. In the partitions between the vascular spaces on its inner surface were well-developed lamellæ of bone.

Cases of angioma of the choroid have been reported by Quackenboss and Stoewer (*Oph. Year-Book*, p. 317, 1909). The patient of the former was a girl of 11, whose right eye had a peculiar look from birth. The vision, always defective, had been lost for a number of years, and the eye at times had been red and painful. Tension was increased. On the lower lid and cheek was a capillary nevus. The pupil gave a yellowish reflex. The iris was atrophic. Anatomic examination of the globe showed a cavernous angioma continuous with the choroid, the lens opaque and retracted, the ciliary body completely atrophied, the retina detached and some ossification of the choriocapillaris. Stoewer's patient was a girl of 9. The left half of the face showed a vascular nevus. The eye was blind with complete cataract, atrophic iris, and tension somewhat increased. This eye had poor sight from birth. On enucleation an angioma of the choroid 16 mm. in diameter, and 7 mm. thick, was found in the outer side of the eyeball. The ciliary body was atrophied, the retina detached. In both cases the eyeball was somewhat enlarged.

Almost all cases of chorioidal angioma hitherto reported have been alike in that the new-growth was only discovered upon eyeballs enucleated on account of inflammatory glaucoma. The case recorded by Reis (*Zeitschr. f. Augenheilk.*, Oct., 1911), however, showed certain

retinal changes which may prove to have some diagnostic significance. The patient was a young man of 19 years. His left eye presented a retinal detachment which overhung the upper nasal quadrant of the disc and extended upward about 4 disc diameters. The prominence had a greenish hue on ophthalmoscopic examination, and its refraction was $+4$ or $+5$ D. A few months later, detachment of the retina in the lower part of the fundus, and an increase in the size of the primary swelling, led to a diagnosis of sarcoma; and the eye was enucleated. The upper nasal quadrant of the fundus presented a flat, spongy swelling, which proved to be a cavernous angioma originating in the outer layer of the choroid. Many enlarged vessels were found in those parts of the choroid which were not grossly affected. The author suggests that flat, slowly-developing, localized detachment of the retina, occurring at an early age, and especially if accompanied by telangiectasis in the skin of the face, should arouse suspicion of the presence of angioma of the choroid. In Bergmeister's case of the same condition, the diagnosis was made after enucleation for glaucoma. The patient was a woman of 26 years. The entire posterior half of the choroid was involved.

See, also, **Choroid, angioma of the**, p. 2168, Vol. III of this *Encyclopedia*.

Carcinoma of the choroid. In addition to the matter on p. 2170, Vol. III of this *Encyclopedia* it may be said here that *primary carcinoma of the choroid* is practically unknown. For this reason Gutmann (*Oph. Year-Book*, p. 368, 1913), who enucleated an eye containing a true choroidal carcinoma situated close to the disc, concluded that his patient must have a cancer in some other part of the body, although so far there had been no sign of its existence. The patient was a man of 50 years. The rest of the cases coming within the scope of his review were all frankly metastatic and secondary to carcinoma of the female breast. Gallemaerts' patient had been operated on ten years previously for cancer of both breasts. Two further operations, three and six years after the first, had been done for recurrences on the right side; a year later still, recurrence on the left side had been operated upon; and there were now multiple general metastases, including those in the eye. In Hegner's case the cancerous left breast had been removed three years previously, and the ocular disturbance, due to a large flat choroidal growth, was first diagnosed as a rheumatic iritis. In Leplat's patient the interval since the primary operation was only a year, and the metastases involved the iris, ciliary body, and choroid.

Another case of metastatic carcinoma of the choroid has been re-

ported by Lafon. A man, aged 42, came with vision of the right eye reduced to light perception, the first impairment having been noticed a month before. Two months before that he had shown the first symptoms of cancer in the right lung. His eye presented detachment of the retina at the posterior pole. A few weeks later this became complete. Tension of the eye was minus 2. Exophthalmos developed, and four months after he was first seen the contents of the orbit were removed. A carcinoma, evidently quite malignant, occupied the posterior portion of the globe, and another mass the apex of the orbit. The patient died about a year from the first evidence of pulmonary involvement.

Suker and Grosvenor report a case, secondary to carcinoma of the left breast, in a woman of 47, who lived ten months after the first symptoms of ocular involvement. The choroidal tumor was flat, and there was invasion of the optic nerve and epibulbar tissue. They add to the collection of cases made by Oatman, bringing the number up to 64 recorded cases (1909), including their own, but not the above case of Lafon. In the 64 cases the tension was normal in 30, increased in 22, and diminished in 4. The period of survival after the eye became involved varied from one month to two years, the average being seven months.

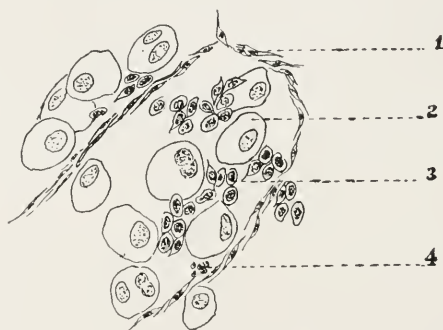
C. A. Hegner (*Klin. Monatsbl. f. Augenheilk.*, July, 1911) has written on *cancer metastasis in the choroid with acute iritis as the first symptom*. Three years after removal of the left breast, on account of cancer, the patient became affected with acute iritis in the left eye, the fundus at that time being quite normal. Three weeks later, when the iritis had nearly disappeared, detachment of the retina and other changes suggestive of a new growth were found, and enucleation was performed. A flat, scale-like, cancerous tumor was present in the choroid.

A report of this rare neoplasm is given by U. Arisawa (*Klin. Monats. f. Augenheilk.*, p. 695, May, 1914). A man, aged 72, had a typical intra-ocular tumor, but in whom the most careful examination of the interior organs showed no anomaly, so that it was diagnosed as primary sarcoma of the choroid. The microscopic examination of the enucleated eyeball, however, revealed carcinoma of the choroid, undoubtedly metastatic. A year after the commencement of the visual disturbance diarrhea, loss of weight and general weakness set in, and the patient died after two months. The post-mortem examination showed a primary, medullary, ulcerated carcinoma of the rectum and small metastatic tumors in the liver. The metastasis took place through the posterior ciliary arteries, as in most cases. In corre-

spondence with these facts were the situation of the tumor at the region of the macula and the intense development of connective tissue in connection with the point of entrance of these arteries. Histologically, the tumor showed great similarity to the metastatic focus in the liver, viz., the structure of a scirrhus. Both metastases developed from the primary, adenoid, cylinder-celled carcinoma of the rectum. Histologic differences between the intra-ocular tumor and the primary carcinoma of the rectum are, however, not unusual in metastases.

A report of two cases of metastatic carcinoma of the choroid is given by John E. Weeks (*Trans. Am. Oph. Soc.*, 1915).

One case occurred in a woman of sixty-four, who had been operated on two years and a half before for carcinoma of the breast, in which



Histology of Week's Case of Epithelioma of the Choroid. (1) Alveolar wall. (2) Sarcoma cells. (3) Endothelial cells. (4) Small cells (leucocytes).

there had been some slight signs of recurrence. When seen, there was a slight detachment of the retina of the right eye and vision, with correction of the error of refraction, of 20/40. This gradually became less. The patient had no pain. Enucleation was not advised at first; although a diagnosis of intraocular neoplasm, probably metastatic carcinoma, was made; because it was felt that if it were a metastatic carcinoma, the operation would not prolong life. The vision went down to 20/50 later, there was some pain, and the detachment of the retina increased. Enucleation was done, and microscopic examination showed the growth to be a carcinoma. Healing proceeded slowly, but favorably. The patient's condition was excellent, at the time of the report, except for a very slight advance in the growth of the nodules at the side of the wound in the breast.

Endothelioma of the choroid. A case of interfascicular endothelioma of the choroid, situated near the optic papilla, is recorded by

George Mackay (*Trans. Oph. Soc. U. K.*, Vol. 30, p. 281, 1910). The patient, a banker, came on Feb. 19, 1909. He had discovered that a slight dimness of vision which he had noted for a day or two was due to a defect in his right eye only, and when tested he was found to have an almost complete loss of the nasal field of this eye. Since then he had improved somewhat. A distinguished neurologist who was consulted found nothing abnormal in his fundi, and ordered iodide of potash with abstinence from tobacco and stimulants.

The patient, *æt.* 60 years, a powerfully built man, of full-blooded aspect, was said to have no cardiac trouble, renal disease, or specific history. He had been a fine athlete in his youth, and noted among his friends for his feats of strength. Pupils equal, about 3.55 mm. in diameter, both reacting to light and on convergence, the right perhaps a little less well than the left. The media clear. Tension normal.

In shooting he aimed with his right eye, closing the left one. He admitted that for about a year past he had at times a sensation as if a long hair from his eyebrow touched the right eye, and often tried to brush it aside with his hand, and he had occasionally experienced color sensations before the right eye in daylight, but there were none at the time of examination, nor for several days previously. The field of vision for hand movements and colors was excellent to the temporal side in the right eye, but misty and defective for both to the nasal side. In the left eye perception was excellent in all directions.

Ophthalmoscopically the left fundus appeared quite normal. In the right eye the disc presented a curious appearance, difficult to define until the pupil was dilated with homatropin. This revealed that the surface of the disc was elevated as if by a grey mass of tumor substance with some fine inherent vascularization. The border, rounded and clear cut towards the macular side and slightly overlapping the papillo-macular area, sloped away more gradually into the retina on the nasal side. The veins, which appeared to be of little more than ordinary size on the retina, disappeared entirely in the disc substance. The vessels arching from the disc towards the macula above and below enclosed a rather smaller area than usual, suggesting the possibility of some congenital abnormality. There was a narrow, dark ring of pigment or shadow round the base of the disc, especially towards the macular side. The prominence of the disc appeared to be about 2 mm. judging by the lens required to focus the neighboring fundus as compared with the summit of the disc. There was a white cloudiness of the retina on the nasal side of the disc and a few capillary hemorrhages (or dilated capillaries?) here and there. It was difficult to say whether the whole change was due to a congenital malformation,

or to something superadded to such a malformation, or was altogether recent. If a neoplasm, was it simple or malignant? The iodide of potash, which had been discontinued, was advised again.

About a month later (March 16th) there was no appreciable alteration. The tension of the right eye seemed a fraction higher than the left. The pupils practically equal, and the vision as before. With his distance glasses on and both eyes open he was not conscious of any dimness of vision.

On May 4th he reported no discomfort. He had been taking the iodide steadily. There had been no further giddy attacks, but he was not seeing quite so well as a week or two before. In reading Snellen's types the right eye got with difficulty down to 6/12, missing most of the letters to the left of the middle line in each row from 6/36 downwards. Ophthalmoscopically, there seemed to be a fractional increase in the mass of tumor and some distension of a vein forming a loop on the temporal side of the mass, which had been less prominent before.

On May 23rd he was seen by Treacher Collins, who gave it as his opinion that the case was one of malignant new-growth.

On July 2nd the eyeball was enucleated under chloroform, cutting the nerve as far as possible, about 16 mm. from the sclerotic. There was a small piece of the tumor adherent at the lower aspect of the nerve sheath, extending about 7 or 8 mm. backwards from the sclerotic, and further inspection revealed a little, isolated, pin-head excrescence on the sheath still farther back at about 14 mm. from the sclerotic. The cross section of the nerve and sheath, where divided by the scissors, appeared healthy. A tag composed apparently of posterior ciliary vessels, of even greater length than the nerve, was also brought away. As the growth appeared to be limited to the nerve sheath no further exenteration of the orbit seemed necessary. Ten days after the operation, Mackay detected a small mass of tumor occupying the apex.

On the 23rd he operated again, and endeavored to make a clean sweep of all the suspicious tissue, leaving apparently only normal conjunctiva, healthy fat, and stumps of muscles. The patient's condition since that date has been satisfactory; he is wearing an artificial eye, is in the enjoyment of good health, and following his profession.

Treacher Collins's final report on the tumor is as follows: There was nothing abnormal detected in the external appearances of the globe, a piece of optic nerve 16 mm. in length was attached to it.

After division of the eyeball into an anterior and a posterior half

by an equatorial section, two detachments of the retina were seen, one just external to the optic disc and the other in the lower and outer part of the globe. The latter extended forwards beyonds the equator and at the point of section a coagulated, jelly-like substance was seen between the retina and choroid.

In the position of the optic disc a rounded nodule projected forwards, starting from the inner side of a circular white raised area to which it was connected by a slightly constricted neck. The retinal vessels passing outwards ran above and below the circular white area which was about two discs' breadth in width.

A section was made through the optic disc, the mass overlying it, and the detachment of retina external to it. A white colored growth of firm consistency was then seen springing from the choroid external to the optic disc and extending over it. The base of the new-growth measured 8 mm.: on section it was lenticular in shape with a nodular protuberance projecting from its inner extremity. The retina was separated from the outer part of the growth by gelatinous material but was in close contact with the inner part.

The growth in the choroid was composed of closely packed, unpigmented cells, with large nuclei and but little cytoplasm, of a polygonal shape. They were grouped in spaces bounded by thin strands of delicate fibrous tissue containing cells with flattened nuclei. A few branching cells, different from those of which the growth was mainly composed, and which contained granules of dark-brown pigment, were seen scattered here and there. There were but few blood-vessels in the growth, the main trunks of the posterior ciliary vessels passed through it and there were some thin-walled capillaries. In the lymphatic sheaths of the posterior ciliary arteries, both in the sclerotic and immediately external to it, groups of cells similar in character to those composing the growth were seen. In places they appeared to be undergoing degeneration and were much vacuolated. In the space between the pial and dural sheaths of the optic nerve just external to the sclerotic, and also in the nerve itself immediately posterior to the lamina cribrosa, there were nodules of the growth. Sections taken from the nerve farther back showed it to be perfectly normal.

There had been some proliferation of the pigment epithelial cells overlying the new-growth and also some edematous changes in the retina, several small cystic spaces having been formed in it.

Epithelioma of the choroid. A woman of 62 years gave a history of being treated for iritis and of visual failure, supposedly due to immature cataract. When seen by Weeks (*Prac. Med. Series, Eye*, p. 167, 1908) the patient was still complaining of pain in her left

eye. It was slightly injected, the anterior chamber was shallow, the pupil of moderate size and irregular from posterior synechiæ; the lens was completely opaque and tension elevated. Transillumination showed a dark area in the lower-outer quadrant. Vision equalled perception of light; projection faulty above and to the nasal side. The diagnosis was made of an intraocular growth and enucleation advised. After the eye was removed the growth was found to involve the outer inferior-anterior portion of the choroid and the ciliary body. It pressed against the crystalline lens and projected into the vitreous, reaching the median line. It appeared to be free from excess pigment. The retina was detached throughout about one-half its extent. The growth developed from the choroid, apparently from the layer of large vessels. The arrangement of the cell masses suggested the so-called alveolar sarcoma.

D. H. Coover reported a case of *choroidal endothelioma* in a woman, aged 76. Three years ago she was struck over the right eye by a picture hook, after this the eye felt full for about one week. For the past seven months noticed the vision had been failing in this eye. With glasses the vision was improved somewhat.

July 23rd, 1914, returned complaining of the eye being uncomfortable. Examination found the vision about nil, and a detachment of the retina in the upper and nasal side of globe was visible.

On February 28th, 1915, she returned complaining of attacks of pain in the eye. These attacks came on at intervals of one or two months. In November, 1915, had an attack of grippe, after which the pain became more severe and lasted longer.

Upon examination Coover found no light perception, lens cataractous, tension plus 3, anterior chamber shallow, the subconjunctival vessels engorged and a marked blush over the ciliary region. The iris showed deposits along the root. Removal of the eye was advised.

March 11th, 1916, the eye was removed and found to contain a tumor. William C. Finnoff's report is:

"Horizontal section of eye shows a tumor, occupying two-thirds of the eyeball. An area $2\frac{1}{2}$ mm. in the anterior portion is deeply pigmented, but the tumor mass, posterior to the area, has very little pigment. The lens is pushed forward into the anterior chamber, which is shallow. The iris is in contact with the cornea over an area of $1\frac{1}{2}$ mm. from its root.

"Microscopic examination reveals a tumor mass, arising from the choroid. It extends from the posterior portion of the ciliary body on one side to 8 mm. from the optic nerve entrance on the other. The tumor cells extend from half of the posterior portion of the lens,

backward to the sclera. The retina is detached and pushed forward by the tumor, and its attachment to the optic nerve has been severed."

Hypernephroma of the iris. This rare tumor has been known to attack the iris and the choroid as a metastasis. An account of hypernephroma of the choroid is given by C. P. Small (*Ophthalmic Record*, vol. xvii, p. 55, 1908). See p. 6107, vol. viii of this *Encyclopedia*.

Melanosarcoma in the eye. S. Hagen (*Norsk Magazin for Lægevidenskaben*, March, 1916; *Abst. Annals of Oph.*, 1916) furnishes a survey of *intraocular melanosarcoma*. It has been generally stated as a point in differential diagnosis that in serous detachment of the retina the intraocular tension is diminished, while in the first stage of intraocular tumor the tension is normal. This is not borne out by the experience of the Christiania clinic, where in six cases diagnosed in the first stage the tension, as measured with the Schiötz tonometer, was, respectively, twenty-one, twenty-three, eighteen, eighteen, eighteen, and fourteen millimeters of mercury. As regards the duration of the disease, so far as indicated by the symptoms, the six patients who were seen in the first stage recorded symptoms as having existed for three months, nine months, two years, eight days, three months, and six weeks respectively. In the case in which symptoms had only developed eight days before the patient was seen, the tumor was already fairly large and must, therefore, have existed for a relatively long period, the absence of symptoms being attributable to the peripheral location of the growth. In two cases only one year or less, and in no case more than two years, elapsed between the first occurrence of symptoms and the onset of the glaucomatous stage. The second stage does not usually exceed one year.

As regards the total duration of the disease, of nine patients who certainly developed metastasis, in three the total period elapsing from the onset of the first stage until death was about three years; in three cases about four years; in two cases about six years; and in one case about eight years.

Of the twenty-eight patients who were operated upon in the eye clinic for sarcoma of the choroid, twenty-four were observed for at least three and a half years. Of these, at the time of writing, twelve were living and well; two had died, apparently from another cause, after respective periods of twelve and twelve and a half years; and two had developed metastasis or recurrence; representing fifty-eight per cent. of cures. The percentage of cures stated by a number of other authors has varied from six to fifty-six; the wide range of difference depending upon a lack of uniformity in classification. There is a general agreement that, as would be expected, the prognosis is

much better in those cases which are operated upon at an early stage.

In the Christiania clinic recurrences were only encountered among patients who were operated upon in the third stage—that is, after the tumor had broken through the ocular coats—being met with in three out of seven such cases. Metastasis occurred, as a rule, in the first four years after operation, the period varying, in eight cases, from two years and five months to six years. If a period of four years has elapsed after operation, regardless of the stage at which the operation was performed, and there is no sign of metastasis or recurrence, the patient may with a fair amount of certainty be regarded as cured; although Hirschberg has reported a case in which a patient operated in the first stage died of metastasis in the liver and heart nine years later. The danger of recurrence appears to be greatest within six months after operation.

From the material of the Christiania clinic, Hagen concludes that the degree of intensity of pigmentation of the tumor has no significance as regards prognosis.

R. Foster Moore (*British Journ. Ophthalm.*, p. 26, 1917) contributes a paper on the *pathology of choroidal melanoma*, prepared in the light of a number of sectioned tumors. He says that a consideration of cases published by Nettleship and de Schweinitz and Shumway lends rather strong support to Nettleship's suggestion, namely, that the presence of stippling or irregular pigmentation over the area of the tumor may indicate that it is actively growing.

The following characters of these growths were determined by the ophthalmoscope: In size they varied from about one-half the area of the disc to about four times its area. They were roughly circular or oval in outline. The edges were everywhere quite definite without being quite hard and sharp; there was no shading off into the surrounding fundus, nor was there any light fringe or evidence of pigmentary disturbance at the edge. They were of quite homogeneous appearance, and the choroidal pattern, although plainly seen around, was not seen over the area of the growth. In color they were exactly that of blue ointment, differing from each other only in their density. All were single and close to the papilla. They were all discovered by chance; none of them having given rise to symptoms.

In one case the sclerotic was not involved by the growth. The mass of the tumor was composed of very broadly spindle-shaped cells which showed a tendency in places to be arranged in coarse bundles. The nuclei were oval and well-formed; evidence of active mitosis was not observed. Pigment was scattered throughout the growth in a somewhat uneven manner. The bulk of it was intra-cellular. In some

places it was contained in globular cells; in other places it appeared to be contained in the long processes of branching cells.

Jonathan Forman (*Am. Journ. Ophthalm.*, Feb., 1918) discusses *melanoblastoma of the choroid*. He remarks that the pigment-bearing choroidal tumors are usually referred to as melanomas. In this region pigment-free tumors are sometimes observed which differ in no



Melanoma of Choroid. (de Schweinitz and Shumway.)

wise either in structure or clinical course from those which contain pigment. Such tumors have been collected by Schieck under the term leucosarcoma. This would appear to be an unfortunate term, because it is used by Sternberg and others to designate those cases in which a definite tumor-like mass is developed in some organ or tissue; and is composed of *lymphoid* cells which seem to escape into the blood stream, giving rise to leukemic alterations of the blood. Ribbert designated both the pigmented and the pigment-free tumors of this

group as *chromatophoromas*. Mallory adopted the more euphonious and equally comprehensive term of *melanoblastoma*. The use of a group name for all tumors composed of melanoblasts, or chromatophores, has the advantage of not placing any emphasis upon benign or malignant forms. This compels a more careful study and accurate evaluation of the individual tumor.

Marshall in his collection of 134 cases of melanosarcoma of the eye, found that the age ranged from 15 to 90 years, with an average age incidence of 50 years. One eye, as a rule, is affected. The cases on record appear to be about equally divided between the left and the right eye. Injury is considered as an important etiologic factor by some authors. Marshall found a definite history of injury in about ten per cent. of his series. Among the fifty-five eye specimens in the Museum of Pathology at the Ohio State University, there are four cases of melanoblastomas arising in the eye.

Pigmented nevus of the choroid. An example of this very rare neoplasm is reported by A. Magitot (*Ann. d'Oculistique*, March, 1916). The article is extensively reviewed by W. C. Souter (*Ophthalm. Review*, December, 1916).

A man of 40 was admitted for a tumor of the ethmoidal sinus, and Magitot, examining the eyes, found a moderate exophthalmos of the left eye, with difficulty chiefly in adduction; fundus normal except for slight fullness of the veins. In the course of the operation it became necessary, quite unexpectedly, to remove the eyeball.

During the section of the eye, Magitot noticed a pigmented bulging of the choroid. It was about 1.5 mm. long in the axis of the membranes, and 0.5 mm. thick, lying almost equidistant between equator and papilla. With the usual stains the sections showed the tumor to be extremely pigmented, obscuring all details, disposed longitudinally and ending insensibly without sharp transition in the surrounding choroidal zones, extending outward to the sclera and invading suprachoroidea and forward to the chorio-capillaris but not beyond it, leaving the retinal pigment epithelium layer absolutely normal; retina pushed forwards somewhat by the tumor but not detached; tumor was traversed by choroidal arteries and veins, but there was no increase in the number or caliber of these vessels, unless possibly the caliber was a little diminished. The retinal layers were all quite healthy. After depigmentation further detail was obtained so that the properly so-called neoplastic tissue was seen to consist of voluminous cells with two aspects, one set of cells polygonal, epitheloid, compressed against each other, size at times 30-35 μ , nuclei oval, choked with chromatin, situated almost at the center of the protoplasmic body, nucleus single,

double or triple; the other cells were fusiform, with plenty of protoplasm and elongated nucleus, suggesting connective-tissue type. Cells of both kinds had protoplasm packed full of pigment granules while the fusiform variety was specially disposed opposite the vessels of the tumor, which possessed their normal endothelial lining. In fact the wall of the choroidal arteries was devoid of muscular and elastic tissue and consisted of the endothelium sheathed by these elongated cells. These fusiform cells abutted on the chorio-capillaris, which acted as the limitans interna of the tumor, but did not penetrate it anywhere. The fusiform cells were disposed peripherally and the epithelioid polygonal ones centrally; all appeared to be adult cells; there was no sign of malignity; on its outer aspect the sclera was free, of normal thickness, and not invaded by tumor cells.

Magitot lays stress on the fact that all the cells were pigmented, that all stages of transition from the polygonal to the fusiform cells could be found, that these were disposed about the vessels, that the retinal epithelium layer was quite intact, to argue that the tumor chromatophores had a mesodermic and an ectodermic origin, and not merely an ectodermal, while in support of this he cites the embryologic findings that the anterior part of the uveal pigment has an ectodermal origin, starting about the fourth month, while the posterior part has a mesodermal, starting not far from the optic nerve towards the end of the fourth month of fetal life. The pigment deposit for the retinal epithelium, however, appears very early, towards the end of the first month.

A noteworthy feature is the association in this case with an epithelioma of the ethmoidal sinus, in agreement with one of Wolfrum's choroidal nevus cases in which the eyeball was removed for an epithelial tumor of the orbit.

Sarcoma of the choroid. About all that was known to the year 1912 about this rather common neoplasm will be found on p. 2173, Vol. III, *et seq.*, of this *Encyclopedia*. The most important paper since that date is the extensive monograph of Fuchs (Graefe's *Archiv f. Ophthalm.*, 77, 2). A good review is by H. M. Traquair (*Oph. Review*, p. 113, April, 1911).

The author's views on choroidal sarcoma are based on a histological investigation of 150 cases, together with a critical examination of the findings of other workers. The subject is discussed under four headings—structure, pigmentation, free pigment cells and necrosis.

1. Structure. Regarding as the most primitive form that in which the cells show no definite arrangement, the author traces the morphological evolution of the more differentiated varieties.

Considering first those in which the nuclei are arranged regularly, but independently of the blood-vessels, the simplest forms consist of compact cell masses having only one definite arrangement of nuclei—(a) in straight columns (Kernbänder); (b) in curved or arched lines (Kernguirlanden); (c) in rounded masses (Kernhaufen). The nuclei lie in an apparently homogeneous matrix and cell boundaries are not visible. The three forms often pass into one another, there being no sharp dividing line between them.

Somewhat more differentiated are the fascicular sarcomata, usually spindle-celled, whose cells form bundles more sharply bounded than the cell formations of the first three forms. Delicate connective-tissue or free pigment cells may be seen between the bundles. A fifth form, the sarcoma funiculatum, consists of round cell-cords separated by spaces containing fluid or connective-tissue. The framework or inter-fascicular tissue is discussed at some length before passing to the second main group, in which the arrangement of the cells is definitely related to the blood-vessels.

The second group includes angiosarcoma, perithelioma, and tubular sarcoma, which differs from sarcoma funiculatum in that each cell-column is hollow and contains a large thin-walled blood-vessel. All are characterized by rapid multiplication of the cells lying next the blood-vessels.

These structure-types are not sharply separate, mixed forms are the rule, and one type passes gradually into the other.

2. The nature and origin of the pigment cells and pigment is gone into in detail. The author considers that the tumor cells arise from the chromatophores of the choroid and are all potential pigment cells, but exercise their power of forming pigment in accordance with not yet fully understood variations in nutrition. They can form pigment from colorless material absorbed from the blood plasma or from necrotic foci, and the amount of pigmentation affords no indication of the age of the cell, nor are the pigmented cells, unable to multiply, as is believed by Ribbert.

In both unpigmented and pigmented sarcomata melanogen exists; in the latter case it is transformed into melanin by a melano-enzyme furnished by the cells. The melanin is absorbed by the cells in which it appears as granules. An account is given of an experiment in which an excised unpigmented sarcoma developed a dark color after exposure to warmth and moisture for three days. The author attributes the change to the setting free of the ferment. He admits, however, that the usual causes of pigmentation are unknown.

3. In the third part of the paper the author discusses certain large

round cells which he calls "free pigment cells." They are only loosely connected with the other sarcoma cells, and often lie by themselves in heaps. The pigment granules are large and are peculiar in often giving an iron reaction with Perl's staining method, and in being less easily decolorized than those of other pigment cells. They arise from sarcoma cells, but possess a more energetic vitality, evinced by their greater assimilation, growth and pigment formation and their active wandering. They are not phagocytes, but elaborate pigment from the surrounding blood plasma. After a period of enhanced activity the cell body breaks up and the pigment becomes free. No explanation of their occurrence is suggested.

The subject of necrosis in intraocular sarcomata occupies the last section of the paper. In general, pedunculated tumors are more liable to this than others, while quite small tumors escape, otherwise the nature of the tumor has no influence on the incidence of necrosis.

The author's theory as to the direct causation of necrosis is that the process is started by the death, owing to insufficient oxygenation, of a group of cells at a distance from the blood-vessels. From these dead cells toxins emanate which lower the vitality of the surrounding cells, and so the process spreads. He offers no explanation of necrosis en bloc.

The clinical signs are influenced by the rapidity and amount of the necrosis and by the freedom with which the toxins diffuse. When the necrosis occurs slowly and gradually it may be impossible to diagnose it. Occasionally the anatomical position of the tumor is such that the diffusion of the toxins is hindered and the inflammatory reaction is limited to the part of the sclera in connection with the tumor. The sclera becomes softened and bulging and an edematous area develops in the episcleral tissue, which, if behind, may cause proptosis, and is visible if in front. Perforation of the sclera is not favored as the tumor is dead at the affected part.

When the necrosis is extensive or total an acute inflammation of the entire inner coats of the eye is produced with marked external signs.

The differential diagnosis from iridocyclitis with increased tension depends on the dilated pupil, absence of hypopyon, extremely high tension and proptosis in the case of a necrotic tumor. There is also the history of sudden inflammation in a blind eye and a grey or brown reflex may be visible.

A severe plastic inflammation results, imbedding the iris and ciliary body in a dense membrane. Posteriorly, excepting in the area of the necrotic tumor, the inflammation is not usually so pronounced. Finally, the eye shrinks. All the ocular tissues are liable to be in-

volved in the necrosis, and the author describes in detail necrosis of the cornea, iris, ciliary body, and choroid, the last being most seldom affected.

The diagnosis of a case of sarcoma of the choroid in a woman, aged 43, was made by Pentscher (*Prac. Med. Series*, 1907) from a migration of sarcomatous elements into the anterior chamber. A black mass, resembling an old hyphema, had accumulated in the lower part of the anterior chamber and measured $1\frac{1}{2}$ to 2 mm. high. A portion of it, evacuated by puncture of the cornea, contained brownish-black, irregularly formed pigment, as found in sarcoma of the choroid. The examination of the enucleated globe showed an intense rarefaction of pigment in the choroid and a sarcoma covering the optic disc from all sides. Similar observations have been made by Hirschberg and Fehr.

C. V. Lodberg (*Annales d'Oculist.*, June, 1913; abst. *Ophthalmoscope*, p. 412, Aug., 1915) reports a case of cavernous melanotic sarcoma of the choroid at the papillary margin with perforation of the retina.

This was a rounded sarcoma, 5 mm. high with a slightly constricted base, 7 mm. to 8 mm. in diameter, starting from the choroid at the lower-inner border of the optic disc. Microscopic examination showed that this was irregularly pigmented, some part of it being quite white, and contained numerous cavities of varying size separated by fairly strong barriers. The bulk of the tumor consisted of bundles of fusiform cells pressed against each other without any tendency to the formation of connective tissue. Most of the cells had large elongated nuclei with one or two nucleoli, but some of the nuclei were ovoid and larger, while some of the cells were round. Most of the cavities were full of blood, some having fine walls and others no wall at all, so that the blood circulated in hollows in the sarcomatous tissue. The pigment was found in (1) the fusiform cells, (2) some cells with excessive ramification, which the author regards as being chromatophores of the normal choroid, and (3) large round cells of migratory character situated around the walls and in the interior vessels as well as in the interstices of the tumor.

The chief points of interest about the case are: (1) that the tumor perforated and invaded the retina instead of causing its detachment; (2) that there were free hemorrhages on the surface of the tumor and in the vitreous during life; (3) that the tumor caused sudden diminution of vision followed by improvement; (4) the ophthalmoscopic appearance of the tumor, which was slightly nodular and of a greyish color with reddish lines and spots (hemorrhages and vessels) on its

surface but with no retinal vessels over it; and (5) the presence of some hemorrhages in the neighboring retina. The author has been able to find only one other case in which sarcoma of the choroid perforated the retina, and that was one very similar to his own, recorded by H. Knapp in 1868. He suggests that the peculiarities recorded in his case are diagnostic of the condition.

H. Moulton (*Southern Medical Journal*, August, 1916) notes the rarity of leucosarcoma of the choroid, and especially of those seen in the first stage. He reports a case in a man fifty-eight years old in which the tumor had given symptoms for two months. The growth occupied about one-fifth of the vitreous chamber. The tension was normal, but the pupil was slightly dilated and did not react to light. The eye was enucleated and microscopically the tumor proved to be a small spindle-celled sarcoma without pigment.

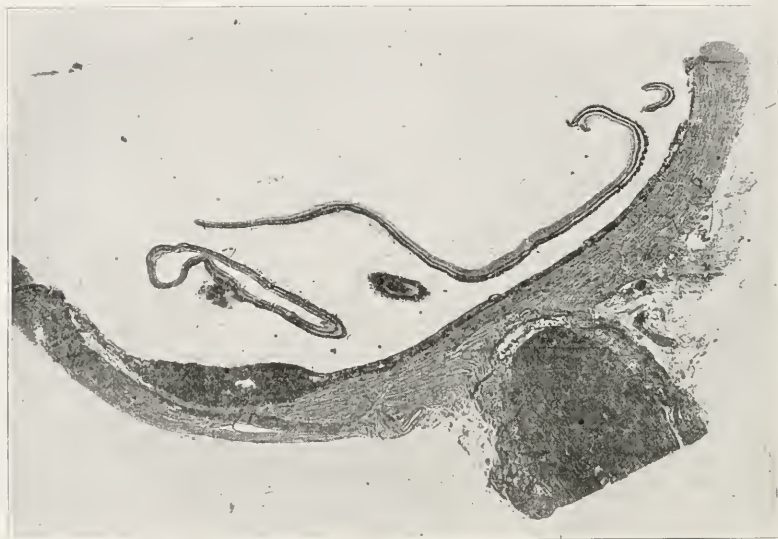
R. Deutschmann (*Zeitschr. f. Augenheilk.*, 33, p. 206) recounts his treatment of a melanosarcoma of the choroid in the left eye of a man, aged 51, whose right eye had been enucleated 37 years before on account of an injury. Mesothorium, 0.01, was included in a capsule, and from 1 to 2 hours sewed into a pocket of the conjunctiva at the site of the tumor. After 9 days the growth had become decidedly flattened. The treatment was repeated after a month. Eight months later the condition was the same. The patient then received four treatments at intervals of about two weeks with the result that the former globular projection of the tumor was replaced by a system of folds with red interstices; its margins were indistinct, but marked by pigment masses. A subretinal effusion was three times drawn off by puncture. As the patient wished to return to his home in South America, the treatment was discontinued. Vision was then fingers at 3 m., visual field more contracted. There was no doubt that the tumor was influenced by the rays, but Deutschmann raises the question whether by disintegration of the tumor material an occasion for conveying it into the body may be created and metastasis promoted.

Raul Arganaraz (*Boletin de la Sociedad de Oftalmologia de Buenos Aires*, third year, pp. 9 and 19) has written two papers on the etiology, pathogenesis and prognosis of sarcoma of the choroid. The first paper is based on thirty cases. In six cases enucleation was done late; in two the tumor had already recurred, and in the other four it had perforated the eyeball.

In only two cases was the operation done in the first stage of the disease, before the development of glaucomatous symptoms. Fourteen patients were operated upon in the second stage of the disease, and after intervals varying from six months to two years from the first

evidence of the presence of the tumor. Fourteen of the patients died from internal metastasis.

As regards the traumatic factor in sarcoma of the choroid, only three out of eighteen patients who were questioned in this respect gave a record of having received a traumatism some time before the appearance of the sarcoma. The time which had elapsed between the traumatism and the appearance of the neoplasm varied between six and twenty months. In view of the great frequency with which traumatism of the eye is encountered, the occurrence of traumatism in these



Choroidal Sarcoma. Very early stage. Low power.
(de Schweinitz and Shumway.)

cases may be regarded as a simple coincidence; or occasionally may have merely accentuated the growth of the neoplasm.

In the course of histologic study of sections of normal eyes, Arganaraz encountered a minute pigmented nodule, measuring one-fourth by one-sixth of a millimeter which he calls the "fetal neoplastic germ."

A case of leucosarcoma of the choroid associated with epithelioma of the lip in the same patient is recorded by J. A. Valentine (*Brit. Journ. Ophthalm.*, p. 540, 1917). A woman, aged 55, with an epithelioma of the lip and glands of the neck removed came, a year after the operation, complaining of loss of vision in the left eye.

Right vision = fingers at 1 metre; the lens was cataractous: the fun-

dus showed a myopic crescent. The left eye had vision 6/36; media clear; conjunctiva, cornea, anterior chamber and iris appeared normal. There was a large limitation of field on the temporal side, when tested roughly by the hand, and she complained of seeing "lights" to the same side.

On examining the fundus, a rounded tumor was seen towards the nasal side, which almost reached the margin of the disc. It appeared to be a sarcoma, but was lighter in color than the usual appearance of choroidal sarcoma. Small vessels could be seen bending around the curve of the tumor.

The tumor eye was excised on Nov. 14, 1916. Vertical diameter of section of tumor, 10 mm. Antero-posterior diameter, 9 mm. Color white, like a section of nerve. A section was made of the tumor by a Research Society, which reported it to be a glioma of the retina. R. Affleck Greeves, however, made the following study of the tumor:

"A large nodule of growth is seen—this is evidently the projecting part of a mushroom-shaped mass, which has been cut across beyond the level of the place of origin of the main mass from the choroid.

A double layer of retina surrounds the nodule, showing that a considerable detachment was present. The growth is undoubtedly choroidal in origin, and consists of a mass of cells which show no sign of any special mode of arrangement. Fine layers of fibrous stroma traverse the mass. Numerous blood-vessels are present—these consist of cleft-like spaces, each lined by a single layer of endothelium. The cells which make up the growth are for the most part of moderate size—they contain well-marked nuclei, which stain deeply with hematoxylin, and enclose distinct nucleoli—the latter are frequently two in number in a single nucleus. Both round-cells and spindle-cells are present—their relative proportions vary in different parts of the growth. No pigment is to be found in any part which appears in the section.

"The growth is a fairly typical leuco-sarcoma of the choroid.

"The occurrence of two different types of malignant disease in the same patient within about a year, is unusual; either growth, unless removed in time, would have had a fatal result, but so far, the patient still enjoys good health. There is no connection between the epithelioma of the lip and the sarcoma."

A few of the papers dealing with the varied aspects of *sarcoma of the choroid* mentioned in the *Oph. Year-Book*, 1909-1916, are discussed as follows: To the cases of choroidal sarcoma discovered at an early stage may be added two of the three cases reported by Le Fever (1909). In one of these, when first seen, a whitish, rounded mass,

TUMORS OF THE EYE

not over three millimeters across, was visible in the lower temporal part of the fundus. Two and one-half years later the mass had increased, but there was no general detachment of the retina. Eight

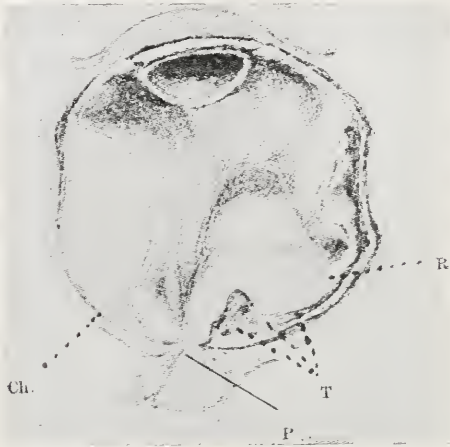


Fig. 1.

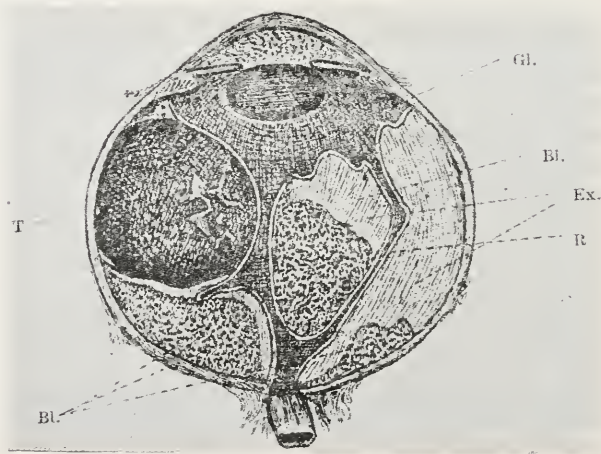


Fig. 2.

Fig. 1. Melanosarcoma of the Choroid near the Papilla.

Fig. 2. Melanosarcoma of the Choroid at the Equator. (Vossius.)

months after that the retina was entirely detached, with no perception of light; and the eye was enucleated. In the second case vision began to fail 14 months before the patient was first seen. The ophthalmoscope showed yellowish-gray irregular areas covering twice the space of the disk. Vision was still 20/30. One year later vision had

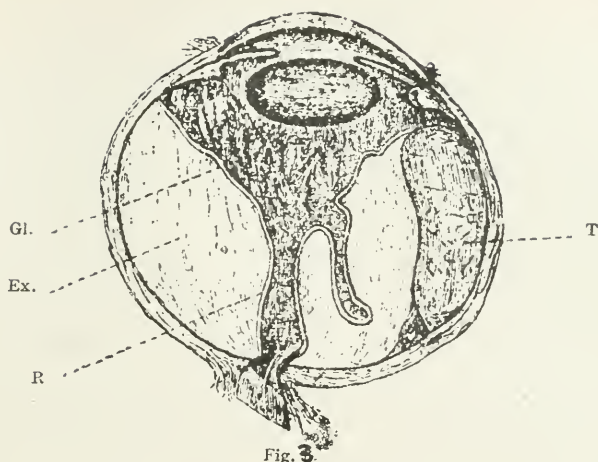


Fig. 3.
Fig. 3.

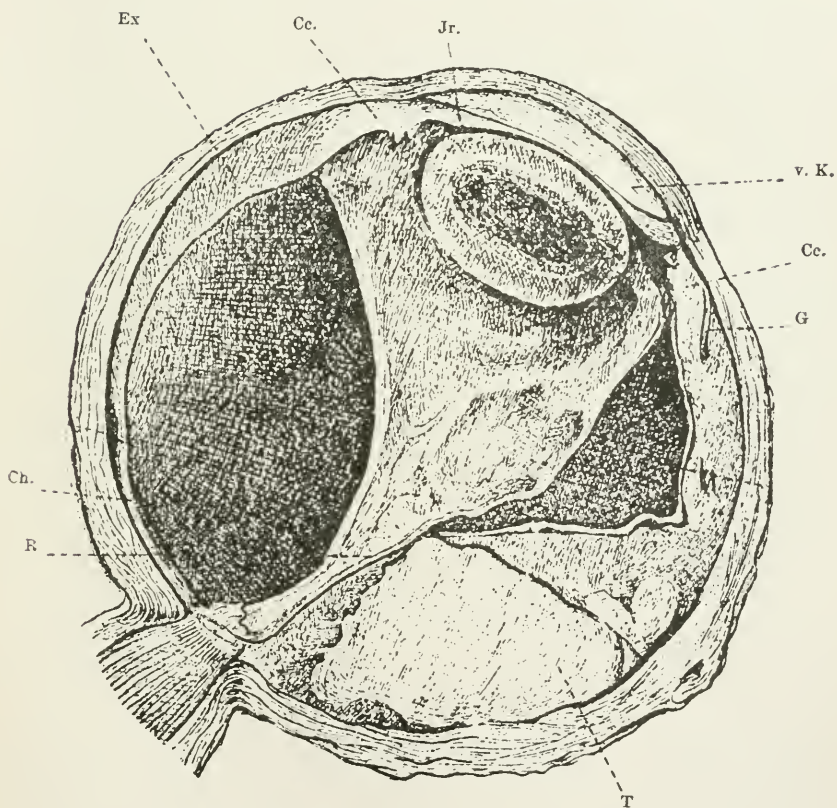


Fig. 4.

Fig. 3. Unpigmented Sarcoma of the Choroid.
Fig. 4. Sarcoma of the Choroid and Ciliary Body. (Vossius.)

fallen to 20/70. Two years after that it was 5/200. A year after that the retina was detached. The eye was enucleated and the growth found. In the third case the dimness of vision had been noticed about 8 months. Within a month there was a noticeable increase in the size of the growth. All three patients remained in good health for periods of 9 to 18 months after enucleation.

Two cases reported by Wintersteiner illustrate the possibility of choroidal sarcoma existing without symptoms. One patient suffered from sarcoma of the orbit, and on examination of the enucleated eye a choroidal sarcoma, 2 mm. in diameter, doubtless metastatic, was discovered. The other case was of a patient who died shortly after a cataract extraction; and the examination of the eye showed a flat leucosarcoma, 5 or 6 mm. across, and one-half mm. thick. Nacht and Weishaupt report a case in which metastatic sarcoma of the choroid first called attention to the primary growth in the liver. In a case reported by Ginsberg the choroidal growth was a leucosarcoma. But pigment epithelial cells were found infiltrating the optic nerve for 3 mm. back of the lamina, forming brown specks visible to the naked eye. The eye was glaucomatous and the optic nerve entirely atrophic. Natanson reports a case in which sarcoma invaded the optic nerve.

Two cases of intraocular hemorrhage associated with choroidal sarcoma are reported by Reis. One of them simulated hemorrhagic glaucoma. In the other case a brownish mass seen in the lower anterior portion of the vitreous, and supposed to be the tumor, turned out to be an encapsulated blood clot, the melanotic tumor being situated below the optic disk. Reis thinks that when some symptoms of intraocular tumor are lacking, apparently spontaneous hemorrhage would point towards its existence.

Jess reports *sarcoma of the choroid* occurring in a child, seen when it was two and one-half years old for an increasing haziness in the pupil. The lens was clouded, the iris bound down to the anterior capsule. A year later the eye was in the glaucomatous stage, with swollen bulging iris; and the diagnosis of conglomerate tubercle was made. But on enucleation a sarcoma of the choroid was found. Rollet and Grandelement, Gamble, McLean, Barek, and Chodina report cases, in which detachment of the retina masked the tumor when first seen. In Gamble's case there was at first lowered intraocular tension, but later, as in the other cases, secondary glaucoma supervened.

Choroidal sarcoma in a shrunken eyeball is reported by Bielsky. The eye had become blind and painful 6 months before, was decidedly shrunken, with lowered tension; but showed a suspicious yellowish reflex in the dilated pupil. Walterhofer also reports a case of cho-

roidal sarcoma, probably the primary condition, in which the eye subsequently became shrunken. The growth had perforated the sclera. Weinstein reports a case in which the sarcoma developed in an atrophic eye, which had been blind 18 years following inflammation. Lately it had become painful, and on enucleation the growth was found. It also had perforated the sclera.

Reis and Le Fever call attention to the danger of exploratory operations, as opening a path for the tumor to escape from the eyeball, thus favoring metastasis and recurrence. The latter finds recurrences are mentioned in about 30 per cent. of the reported cases; but often the reports are published soon after the operation. Wagenmann records a case, in which sarcoma recurred in the scar eleven and one-half years after enucleation of the eye for choroidal tumor. Exenteration of the orbit was then done, and eight months later there had been no further return of the growth. Wagenmann also records a case of recurrence one year after enucleation, and in another case there was a second recurrence in the preauricular glands 5 months after removal of the contents of the orbit. He also reports an additional case of choroidal sarcoma; and other cases are reported by Herzig, Heymans, and Poissonnier.

A patient seen by Veasey (1912) came on account of great pain and marked orbital cellulitis. The enucleated eye contained a large choroidal sarcoma. Myashita reports two cases in which early choroidal sarcoma was associated with tenonitis, the symptoms being conjunctival chemosis, redness, pain on movement of the eye, and slight exophthalmos. The author gives an analysis of the cases in the literature of this tumor in which intra-ocular inflammation occurred. In more than half, necrosis was present in the growth. In a case of spindle-cell sarcoma illustrated by Webster, differential diagnosis between tuberculosis and tumor of the choroid was for some time in doubt. The tumor was seen as a large slate-colored, almost circular path near the optic disc. The diagnosis was established by use of the ophthalmodiaphanoscope, which readily distinguished the dark opaque growth from the rest of the fundus.

Two cases of flat sarcoma of the choroid are reported by Wescott, who puts at forty-five the number of cases of flat sarcoma of the uveal tract previously recorded in the literature. In one case, from various causes the eye was not enucleated until five years after symptoms were first complained of; and a year later the patient died of secondary growth in the liver. The same condition produced a fatal outcome in a case reported by Lilley, in which the eye had been enucleated ten years earlier for melanosarcoma.

Ruben's attempts at intra-ocular transplantation of rat sarcoma were successful in a small percentage of the inoculated animals. Most of the positive results were had in eyes which also developed cataract, probably due to injury of the lens incident to the difficulty of working on such small eyes. It is therefore suggested that the tumor found favorable pabulum in a mixture of lens substance with aqueous humor. Necrosis in the resulting tumors, which grew with great rapidity, showed no dependence on the degree of vascular development. Attempts at implantation in the anterior chambers of rabbits were completely unsuccessful when the lens was not injured. But in one case in which the inoculation was followed by discission of the lens, the implanted fragment grew for eighteen days. After this time, the wound in the capsule having healed, the growth also underwent rapid dissolution.

Fuchs reports three minute choroidal sarcomata which are probably the smallest so far recorded. The smallest of the three was found in the eye of a patient who had died from cerebral cysticercus. It measured between 0.7 and 0.8 mm. in diameter, and was 0.15 mm. thick; and consisted of long spindle cells containing a few light-brown pigment granules. It had apparently originated in the layer of large vessels. A mushroom-shaped sarcoma studied by Duclos and Sabot presented at its base the histologic structure of ordinary diffuse choroidal sarcoma, with blood vessels only poorly indicated. The spreading summit of the growth was arranged around very distinct vascular systems, and was of the nature of perithelioma. This histologic transformation of the neoplasm seems to indicate the identity of perithelioma with common sarcoma.

Von Szily offers a rather diffuse account of his studies as to the origin of the melanotic pigment in the eye of vertebrate embryos, and in sarcoma of the choroid. The essential results seem to be that the pigment is derived from the chromatin of the nucleus, especially during mitosis; and that in the chick embryo unpigmented cells were frequently derived from typical pigment-bearing cells of the retinal pigment layer. In the same microscopic field it was possible to study every stage of transition between non-pigmented and pigmented cells, so that the two forms evidently represented the same structure at different periods of development.

In a patient seen by Bray, metastasis to the liver was discovered eight years after enucleation of an eye containing at the posterior pole a melanotic sarcoma the size of a small hazel-nut. In Wescott's patient, a small tumor of the left breast and a small axillary gland were removed before anything abnormal had been found in the ocular

fundus, although the upper nasal field of the right eye was blind. Three years later the sight of the eye was completely lost, but by this time the patient had symptoms pointing to malignant tumor involving the pleura. The blind eye was enucleated by Wescott after a diagnosis of sarcoma of the choroid and ciliary body had been made. The patient died shortly from an intercurrent affection. Sections from the breast tumor, from the axillary gland, and from the choroidal growth all showed the characteristic structure of melanotic sarcoma. The ocular tumor was regarded as the primary growth.

Lange reports the case of a woman of 57 years who had so far enjoyed freedom from metastasis for 6½ years after exenteration of the orbit for an intraocular pigmented sarcoma which had not only developed a large extraocular mass extending from the limbus, but had invaded the whole optic nerve at least as far back as the foramen opticum.

In connection with his report of a case of choroidal sarcoma covering the optic disc, Greenwood emphasizes the diagnostic possibilities of a lamp for posterior transillumination of the eyeball such as was described by Laneaster. The juxtapapillary sarcoma recorded by Lodberg, and which measured 7 or 8 mm. in diameter by 5 mm. in depth, had perforated instead of elevating the retina, probably on account of the firm attachment of that membrane at the margin of the disc.

A case of choroidal sarcoma completely covering the disc is described by Perrod. In Keiper's case there was some evidence of secondary involvement of the retina by the sarcomatous growth. Wagenmann was able to observe clinically a sarcoma at the posterior pole of the eye which had not detached the retina, and had a prominence of only 4 to 5 D., although microscopic examination showed several points of extension along the vessels and a nerve to the sclera.

In the specimen demonstrated by Aurand and Genet, from a woman of 70 years, the sarcomatous growth appeared in three more or less independent parts, one occupying the posterior third of the fundus, a smaller one in the equatorial region, and a third involving the periphery of the iris and the whole of the ciliary body. These three tumor masses were connected by thickened and edematous choroid, containing connective tissue and pigment cells. The patient came on account of a hyphema in the blind eye.

A case of angiosarcoma was followed by Teulières from the appearance of the initial symptoms, through a long period in which no ophthalmoscopic signs existed. He describes a series of symptoms which he believes to be characteristic of the early stages of choroidal sarcoma at the posterior pole. A year elapsed between the appear-

ance of the first functional disturbances, and the development of a retinal detachment which was clinically discoverable. The patient first experienced transitory clouding of vision, some uncertainty of color vision, dyschromatopsia for green, and metamorphopsia (micropsia). There was very slight hypertension of short duration. Ophthalmoscopic examination showed edema of the retina, which disappeared under the use of eserin. The symptom which Teulières regards as the most valuable was a progressive hypermetropia running parallel with diminution of visual acuity, and with conservation of central fixation. There was thus a gradual lifting of the retina, without detachment, and during this stage the retina showed no ophthalmoscopic change, either of color or in the size of its vessels. Exenteration of the orbit was done eight months after the first appearance of distinct retinal detachment, and to the date of report, 26 months later, there had been no recurrence.

Castresana has encountered sarcomas of the choroid in the proportion of five or six to each 10,000 patients with eye affections, about the usual average frequency. He emphasizes the extreme importance of an early diagnosis, and discusses the first signs of the affection as he studied them in three recent cases. One patient was a man aged 59 years, who noticed a blurring of the vision one year previous, and later a dark spot in the field of vision. The diagnosis of circumscribed hemorrhage, or tumor in the choroid, was confirmed by bulging into the vitreous. Enucleation and section showed melanosarcoma. The second case was a man aged 30 years, who six weeks following an injury by a piece of dirt, found that vision was imperfect. A large tumor was found in the choroid. The third, a man aged 60 years, four years after having received a blow on the eye, noticed an oval spot which interfered with vision. In all cases the eye appeared normal until examined with the ophthalmoscope.

de Schweinitz and How observed a leukosarcoma of the choroid in a man aged 41 years. The growth 6 mm. by 1 mm. occupied the lower nasal quadrant. It was composed of small cell tissue, each cell with a relatively large nucleus. There was no pigment. Origin was from the vascular layer of the choroid 1 mm. from the disk. Moulton's case of the same type of growth was in a man aged 58 years. The mass was of recent development and occupied the upper nasal quadrant. Among a dozen cases of melanotic sarcoma the author has operated on, four had not penetrated the globe. All of these were living and well, two more than five years, one three years, and one only a few months.

Zentmayer had under his observation since 1909 a case of sarcoma of the choroid in a man aged 49 years. He complained of a black spot

in the nasal field of the left eye which he had first noticed two years before. There was a mound-like swelling beneath the retina between the papilla and the macula, about the diameter of the disk in size. Enucleation was advised but declined. Secondary glaucoma supervened seven years after the initial symptom. Microscopic study by Brinkerhoff showed that the growth was a mixed-cell *melanotic sarcoma* in which the spindle-cell vastly predominated. Schwenk's patient with melanosarcoma of the choroid complicated with senile cataract, was a man aged 60 years. Failing vision had been noticed for two years but more rapid loss within six months. Above the corneal limbus were two round areas of bluish-black pigment about 2 mm. in diameter. Posterior synechiæ were present and the tension was plus 2. Transillumination resulted in a diagnosis of intra-ocular growth occupying the upper outer quadrant. The diagnosis was verified microscopically. Heckel's patient was a man, aged 48 years, whom he had under observation for four years. The tumor, melanosarcoma, originated within the eyeball. Following enucleation orbital invasion occurred. Radium was inserted into the orbit four times, thus holding the disease in abeyance, at least, if not cured.

Bussey and Shuman's case which is of more than passing interest, is reported as one of small round-cell melanosarcoma of the choroid, in a female child, aged 3 years. Following enucleation, healing took place rapidly, leaving a clean orbit. One month later the child died with clinical evidence of an intra-cranial growth. Autopsy revealed a tumor within the interpeduncular space involving the chiasm. Three out of five pathologists expressed the opinion that the tumor was a small round-cell sarcoma of the choroid with metastasis to the optic chiasm.

B. Castresana (*Archivos de Oftalmologia, Hisp.-Am.*, Vol. 17, page 426, 1917) writes on the early diagnosis of choroidal sarcoma.

Three cases are described. In the first, the initial symptom was loss of visual acuity, with the presence of a fixed shadow in the upper part of the field. An early diagnosis was not made in this case, although the patient was seen by several ophthalmologists. Later, there was observed a roundish eminence of dark color, with newly developed blood vessels in its vicinity. The retina was not detached. In the second case the presence of a melanotic sarcoma in the early stage of development was determined by means of a magnifying lens and lateral illumination, the observer, looking in a very oblique direction, being able to detect a small choroidal tumor near the ciliary processes.

In the third case, the initial symptoms were a defect in the visual field, loss of visual acuity, and an immobile tumor situated in the an-

terior part of the choroid near the ciliary processes, crossed by blood vessels, and which could be made out with oblique illumination through the dilated pupil, about two millimeters behind the iris. As regards the differential diagnosis of detachment of the retina, there was in this case a detachment in the peripheral part of the tumor, but at the most prominent part of the neoplasm the retina remained adherent and stationary. Whereas the first two patients did not recall any luminous sensations during the early stage, the last patient had noticed, from the beginning of the affection, halos and flashes in the darkness. These luminous sensations are to be explained as due to the first irritations which are produced in the retina by the minute tumor. None of the patients experienced pain in the first stage of the disease.

C. A. Veasey (*Northwest Medicine*, July, 1919) reports two cases of melanotic sarcoma of the choroid in which enucleation was done.

In the first case the growth had progressed to the inflammatory glaucomatous stage, when its presence could be suspected only by the clinical history and general appearance and not by direct ophthalmoscopic examination. Moreover, in this case there was no area which did not transilluminate well, because the growth was situated so near the posterior pole of the eye.

The second case was also in the glaucomatous stage, when no ophthalmoscopic examination could be made, but there was some interference with transillumination, so that the probability of an intraocular growth was suspected because of this fact, together with the clinical symptoms.

The macroscopic appearance of the tumor in the first case was that of a mushroom, attached to the choroid by a small pedicle.

GROWTHS IN THE VITREOUS.

With the exception of cysts *primary neoplasms* of this body practically do not exist. Brewerton (*Oph. Year-Book*, p. 207, 1913) reports a case that came on account of iridocyclitis. When the inflammation had subsided, the fundus was examined and two cysts were discovered in the vitreous. They were oval, with the long axis vertical; measured one and two disk diameters respectively; and were situated near the disk. The retina was detached, and the retinal vessels could be seen indistinctly through the cyst walls. In Shine's case, a cyst measuring about two disk diameters floated freely just behind the ciliary body below or slightly to the temporal side. The cyst was regarded as congenital, and as probably composed of epithelium derived originally from the ciliary body.

See, also, p. 3681, Vol. V, of this *Encyclopedia*.

TUMORS OF THE RETINA.

Many new-growths in the retina have already been discussed—some of them quite extensively—in this *Encyclopedia*, under the several appropriate headings, especially under various **Retina** captions, beginning with **Retina, Angioglioma of the**, p. 11187, Vol. XIV. See, also, such rubrics as **Glioma of the retina**, p. 5582, Vol. VII; and **Cysts, Retinal**, p. 3700, Vol. V. The subject of retinal neoplasms is further discussed, illustrated and brought to date under this present heading.

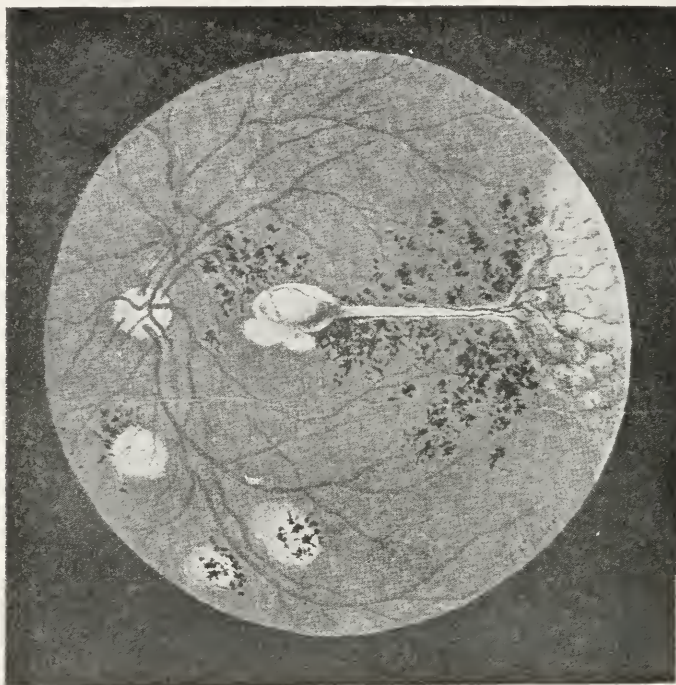
Elmore Brewerton (*Am. Journ. Ophthalm.*, April, 1919), has reported a case of angioma of the retina. The pathology was somewhat difficult, but he considered it a cavernous angioma. He gave his reasons for believing that the distinction of veins was mechanical, and that the disease was in the lower, oval swelling in the periphery. Such cases were practically never seen in old age. He regarded it as a congenital, faulty development of the capillaries in that part of the retina, that these capillaries dilated into cavernous spaces, and there caused an oval limited area of angioma. The prognosis in the case he did not regard as favorable; the veins would probably, sooner or later, begin to leak, indeed there was already slight exudation. The patient would probably, he believed, have an intraocular hemorrhage, which might clear up, but a second one would result in the loss of his sight. See, also, p. 11190, Vol. XIV, of this *Encyclopedia*.

Cysts of the retina. In addition to the matter on p. 11206, Vol. XIV, brief abstracts from the *Oph. Year-Book*, 1912 and 1913, furnish reports of a number of cases. Velhagen reports microscopic examination of two eyes enucleated for secondary glaucoma, in which, along with general detachment of the retina, cysts were found. The patients were 62 and 64 years of age. Cystic disease occurring in a child is liable to cause removal of the eye on a diagnosis of possible glioma. Under the heading pseudo-glioma Krauss reports the case of a boy 8 years old. The greenish-yellow reflex from the pupil had been noticed for four months, but there had been several attacks of slight redness and inflammation of the eye before that. The retina was completely detached; there was subretinal hemorrhage with partly organized exudate resembling a tumor between the lens and the retina. Near the optic disk the layers of the retina seemed adherent, but no distinct cyst was found.

Bailliant reports the case of a young woman in whom a cystic mass was seen, fixed against the wall of the eyeball in the upper external portion of the retina. Leplat showed a woman of 44, from

whose retina, far forward, arose a globular body upon which were numerous vessels. This did not interfere with transillumination. The vitreous was transparent, and the remainder of the retina intact. The diagnosis seemed to lie between a cyst and a cysticercus.

The clinical and anatomical findings of four cases of retinal cyst formation secondary to inflammation of the anterior segment of the eye, complicated by papillitis, have been presented by Inouye. He concluded that the cyst formation is due to an edema, induced by the



Congenital Multilocular Cysts in Relation with the Retina, and Associated with Quiescent Pigmentary Retino-Choroiditis.

inflammation or by vascular changes. One case complicated by choked disk followed perforating trauma is held by him to be due to toxins of an unknown nature. These toxins, formed in the anterior segment of the eye, reach the optic nerve head by the natural drainage channels, both lymphatic and vascular. A true genetic relationship does exist, however, between papillitis and cyst formation in the retina. Terrien reports a case of cyst of the optic nerve accompanied by an apparent microphthalmos in a child of 8 years of age. The microphthalmos (pseudo) was due, however, to a retraction of the anterior

segment of the eyeball, for the rest of the ocular dimensions were normal.

Fujita has examined microscopically three eyes showing a cyst formation in the detached retina. In one case the cysts appeared as multiple blisters on the outer surface of a funnel-shaped detachment. In the third the cysts were small and limited to the macular region, which was slightly separated from the choroid by exudate. In the case reported by Derby the sight had been failing for two and one-half years, in a man of 40, who had then suffered from "typhoid pneumonia." Vision was reduced to right, 2/60, left, hand movements at 6 feet. There was detachment at the retina in both, complete in the left, the lower half in the right. To the temporal side of the right disk was a pear-shaped prominence partly overhanging the disk over which ran a few tortuous retinal vessels. The tumor was translucent, slightly smaller than the disk and toward the temporal side a globular swelling was seen. The appearance of the case had not changed much in four months.

Laws reports a case of cystic appearance at the periphery of a detached retina. A hemispherical bulla with a diameter of three disk breadths or more projected into the vitreous. Retinal vessels were seen on its smoothly distended wall, and there was a little granular opacity in the vitreous at its base. The patient was still able to count fingers at several feet. At the end of six weeks there was little change in the external eye. In an eye enucleated eleven months after rupture of the sclera Oguchi found the retina thickened and undergoing cystoid degeneration affecting the external nuclear layer in the neighborhood of the macula.

Glioma of the retina. The reader is referred, as an introduction to this subject, to p. 5582, Vol. VII of this *Encyclopedia*; also to **Neuroepithelioma retinae**, p. 11277, Vol. XV.

George Coats and J. Graham Forbes (*Ophthalmoscope*, May, 1911) note that it has long been known that metastatic ophthalmitis occurs with some frequency in epidemic cerebrospinal meningitis, but that the meningococcus is capable of causing, in children, a metastatic ophthalmitis of pseudo-gliomatous type, without associated symptoms of meningitis, appears to have escaped recognition.

They found the meningococcus in four cases of metastatic ophthalmitis of pseudo-gliomatous type, and are led to believe that a specific causal relation may be established between this organism and pseudo-glioma. "Apart from our own observations," the writers state, "we base this opinion on the following considerations: (a) Pseudo-glioma is a well-defined clinical entity, and is therefore not

unlikely to be due always to the same organism. (b) A form of ophthalmitis identical with pseudo-glioma occurs in from 4 per cent. to 5 per cent. of cases of epidemic cerebro-spinal meningitis; the meningococcus has been recovered from the eye in such cases. Pseudo-glioma and cerebro-spinal meningitis are both diseases of childhood and both are sometimes associated with arthritis. (c) In idiopathic pseudo-glioma a history of head symptoms, probably due to meningitis, is very frequent; two of the cases prove that even when the history is not of head symptoms, but of measles, the pseudoglioma may still be due to the meningococcus."

Leber (*Graefe's Archiv für Ophthalm.*, 78, 2; abstr. *Oph. Review*, p. 151, 1912) notes that the presence of cells in glioma of the retina resembling the spider-cells of glioma of the central nervous system and the neuroglia cells of Deiter was shown by Greef in 1895 by means of Golgi's method of staining.

The author discusses the views of various workers as to the nature of these cells and their relationship to retinal glioma, and finds himself unable to agree with the explanations offered and up to the present generally accepted.

Using specimens for the most part hardened in Müller's fluid and stained with thionin-blue Leber found two chief features in several of the tumors examined. Some portions showed an epithelium-like structure presenting moderately stained nuclei with a distinct chromatin framework, while immediately adjacent were regularly found parts showing "pyknotic nuclear degeneration," the nuclei being shrunken, darkly-stained and deficient in chromatin. This appearance is due to a regressive cell-degeneration of a mucinous nature, and in the affected areas cells with numerous processes occur which are to be regarded as false spider-cells. No spider-cells were found in the undegenerated parts.

The author holds that these false spider-cells result directly from mucinous degeneration of glioma cells, and that the existence of true spider-cells cannot yet be considered as conclusively established. At the same time our views as to the origin of the tumor cells of retinal glioma from retinal cells remain unaffected.

Deutsehmann (*Zeitschr. f. Augenheilk.*, March, 1912) reports the following case of atypical glioma of the retina. A healthy-looking boy was brought with the history that the mother observed a bright shine from the left eye about three or four months before. The pupil was wide and immovable and gave a yellow reflex from the depth. Ophthalmoscopically: Optic disk visible; close to it a large globular detachment of the retina; in its surroundings two pinkish-white,

irregular foci, half the size of the disk, on a level with the retina. Vision of right eye was normal. Upwards and near the macula there was a gray projecting infiltration of the size of three disk-diameters. Near it were small pinkish foci as in the left eye.

The diagnosis of glioma retinae of the both eyes was made, and enucleation proposed, but not accepted. Thinking of the possibility of conglomerated tubercles, von Pirquet's test was made with negative result, but a rise of temperature of 39.1° C. occurred on the third day. A regular tuberculin cure was instituted, without general or local reactions, alternately with injections of cacodylate of sodium, followed by energeticunctions of mercurial ointment. After four months' treatment the thickening of the right retina was reduced, and the tumor of the left eye had shrunk. A week later the patient returned after a fall on the head. The left eye showed typical glioma nodules and was enucleated. After three months the tumor of the right eye had almost subsided.

The histologic examination of the left eyeball showed a tumor which had originated from the outer side of the pigment epithelium of the retina and had produced metastases all over the retina and choroid, which showed the typical structure of glioma with concretions of lime. This fact has not been described in literature, but corroborates the opinion of Wintersteiner that glioma may develop from any layer of the retina.

Between the years 1912 and 1919 a number of brief but valuable abstracts of the literature of glioma retinae have appeared in the *Ophthalmic Year-Book*. Some of these are here reproduced.

Curt Adam (1912) reviews the cases of glioma of the retina which were seen in von Michel's Berlin clinic during twenty years. There were forty-seven, or one case to every 5,832 out-patients. The percentage is 0.0172 against Wintersteiner's 0.04. All the patients were less than 12 years old, 94 per cent. being under 4 years. All the cases in which enucleation was done in the first stage of the disease were free from recurrence after three years. Of cases in which the disease had spread to the optic nerve, only eight were permanently cured. Every case in which the eye had ruptured, or in which the growth recurred, was fatal. In Caspar's experience of 40,000 eye patients, glioma occurred only three times. He reports the occurrence of glioma in the right eye of a baby whose mother's left eye had been enucleated for the same condition nineteen years earlier. From the Utrecht clinic De Kleijn gives statistics of the results of enucleations for glioma. As regards four cases in which the optic nerve was microscopically free from disease at the time of operation, the subsequent rec-

ords showed no fatalities. Where the optic nerve was affected, but not up to the point of division, two patients had been well for eight and seven years, respectively, and four had died. Of five cases in which the optic nerve was diseased at the point of section, only one had lived, the interval since operation being four years. In three cases the nerve was not examined, and of these one only was still living, after a period of twenty-four years.

In the non-fatal case in which gliomatous tissue was certainly left in the orbit, a tumor appeared in the other eye three months after operation. The patient was lost sight of, but four years later was traced in a blind asylum. The remaining eyeball was greatly shrunken. On removal it was found to have undergone marked calcareous and bony degeneration, but still contained necrotic tissue which proved to be gliomatous. This case differs from one reported by Knieper in that the latter had shown involvement of both eyes at the first examination. The more involved eye was enucleated and glioma demonstrated with the microscope. But removal of the second eye was refused, and the patient disappeared. Eleven years later he was accidentally discovered in an asylum for the blind. The second eye was completely phthisical and free from inflammation. The parents stated that the eye had first become enlarged and painful, and then had ruptured and shrunken.

From a study of seven cases Del Monte distinguishes two forms, one of which is designated as tubular glioma. This is characterized by perivascular sheaths of glioma cells, occurring in well preserved portions of the retina, and also by the transformation of some of the vessels into connective tissue cords. The author was able to demonstrate the intermediate steps between the connective tissue elements of the vessel wall and the cells of the neoplasm. He believes that this transition cannot be explained on the basis of an epithelial origin; but must be taken rather as indicating a connective tissue origin for the tubular form of retinal glioma. The first of the two gliomas studied by Guglianetti was accompanied by a pseudohypopyon which occupied the lower half of the anterior chamber, and was found microscopically to consist of amorphous material containing glioma cells. The second growth was peculiar in the appearance of plasma cells around its blood vessels and in their adventitial sheath. In both tumors were found a few Wintersteiner rosettes. By experimentally influencing the embryonic development of the fowl, von Szily was able to produce both malformations and actual tumor-like structures of the retina. The latter varied from retinal epithelial cells in typical rosettes having a central lumen, to definite glioma masses.

Lewis reports three enucleations for well-developed retinal glioma; with freedom from recurrence so far, for periods of nine, three and eleven years respectively. Ayres reports one bilateral and one unilateral case; and Stoll one case of double glioma.

Gallemaerts saw a case of bilateral pseudoglioma with uveal ectropion. In each eye the vitreous was filled with a yellowish vascular mass. But both eyes were soft, and the author concludes that the case was one of prenatal uveal inflammation. A like explanation is given for a very similar case reported by Moret, in which, however, only one eye was affected. In this instance, the pigment ectropion covered a large part of the anterior surface of the iris. The other eye presented the characteristic traces of iridochoroiditis. The pupil was secluded, and was filled with an exudative membrane, and the anterior chamber was almost completely abolished.

A yellowish-brown, or snuff-colored deposit was observed in the anterior chamber in Walker's (1916) case of *glioma of the retina*. The deposit consisted of mononuclear cells, some with large pigment granules. The patient, a boy aged four years, came with no enlarged vessels or increased tension; light perception doubtful and a brown reflex from the pupil. The eye was enucleated, supposing the growth to be sarcomatous. Subsequent examination showed typical glioma. Three weeks later three quarters of an inch of the optic nerve was excised but three weeks after that it recurred, and attained the size of a cocoon before serious cerebral symptoms developed.

Nettle's case occurred in a child aged three years. Three weeks following enucleation, recurrence at the inner canthus was observed. Three months after operation death occurred following symptoms of cerebral involvement. Microscopic examination showed secondary invasion of the choroid, and also a cluster of the tumor cells outside of the globe. Lawson's patient, aged 3½ years, had a recurrent glioma in the orbital tissues six months after removal of the eye. Evisceration was done. After the next recurrence 90 mg. of radium were applied for four and a half hours. At six weeks there was no recurrence, but at three months it had taken place, causing death.

Paparcione's case of retinal glioma in a boy, was observed at the unusual age of thirteen years. It is described by the author after microscopic examination, as endophytic glioma of the retina, with metastasis into the vitreous, neuro-epithelial glioma, gliosarcoma or gliosarcomatodes. An interesting feature of the history is that the tumor appears to have developed as the result of trauma, received one month previous to observation. Taylor and Fleming's case was bilateral, with multiple metastasis, in a child, aged three months. An

abnormality was first noticed in the left eye. The left eye presented a fungating mass protruding between the lids. The right was much enlarged, optic nerve involved for a distance of half an inch. There was recurrence after extirpation, followed by death. The growth contained closely-packed, small round cells, with large deeply-staining nuclei; a few spindle-cells were present.

Marion's patient, a boy aged sixteen months, showed at autopsy a glioma about the size of a walnut, laying between the optic thalami. Careful notes of the progress during the child's illness of four months are presented. Two months after the onset of symptoms Fowler reported the beginning of a choked disk. Two weeks later Snell reported negative disk. Wassermann was positive. Roentgen ray showed what apparently seemed to be an occipital fracture. The sutures of the cranium were widely separated. At autopsy the supposed fracture proved to be a rather dense line of ossification. The separation of the sutures explained the beginning choked disk with later subsidence. With the increased edema, pressure within the cranium was greater, causing a separation of the sutures and subsidence of the optic nerve changes.

J. Meller (*Cent. f. pkt. Augenheilk.*, 30, p. 101, 1915; abst. in *Oph. Lit.*, 1915) remarks that Graefe and others have emphasized the statement that glioma is not a tumor which is capable of retrogression. In Meller's case, however, not only did five years elapse without advance in development of the tumor, but in the latter part of this period there were definite signs of retrogression. The patient, a boy of four years, was brought in July, 1910, with the statement that the right eye had turned out since birth, and had always looked different from the other eye. In recent months the eye had shown increasingly a yellowish sheen. The retina of this eye was detached and came close to the posterior surface of the lens. Careful examination of the other eye, in which the parents had noticed nothing abnormal, showed the presence of several circumscribed tumor nodules, the largest of which were close to the lower inner margin of the disc.

Enucleation of both eyes was refused by the parents. In order to do something therapeutically, the eyes were subjected to treatment with the x-rays, iodine was given internally, and a "bath" cure was ordered. Examination early in September of the same year showed no change in the condition of either eye, but a week later it was necessary to enucleate the right eye on account of acute glaucomatous symptoms. In June, 1911, the condition of the left eye was found unchanged. In December of the same year, the author got the impression that the tumors in this eye were slightly larger, but he was unable to perceive any change in the nodules during 1912.

The patient was lost sight of until the end of March, 1915. At this date the right orbit was found free from recurrence. The retinal foci of the left eye were present in the same size and shape as previously, but they had become flat and had, to some extent, the appearance of areas of choroidal atrophy, from which they differed in containing fragmentary, white, chalky masses. At the first examination these nodules had been covered by numerous large tortuous vessels, but these had now almost disappeared. Histologic examination of the enucleated right eye showed the typical picture of *glioma exophytum*. Rosette figures were not found. The condition of the eye was otherwise that of secondary glaucoma in a tumor eye. Although the description given by the parents pointed strongly to the presence of the tumor at birth, yet when the eye was enucleated at the age of four years, the tumor had not undergone very extensive neoplastic changes. Outside the retina and the subretinal space the remaining tissues of the eye were still intact, and in the choroid only could the first evidences of daughter nodules of the tumor be found. The simultaneous diminution in size of all three growths in the left eye points to a distinct retrogressive change.

The temporary retrogression in gliomatous growths described by other authors began almost without exception with a shrinking of the eyeball. In Wintersteiner's case the retrogression proved of short duration, and the tumor resumed its development after two months with a fatal outcome. Axenfeld has since reported a case in which apparent cure of glioma nodules of the retina followed repeated intensive Röntgen radiation, but Meller is satisfied that in the case he reports the use of the Röntgen rays was not responsible for the favorable outcome.

Sydney Stephenson (*Ophthalmoscope*, Jan., 1916) reports two cases of retinitis exudativa, or retinitis hemorrhagica externa, a condition differentiated several years ago by George Coats. Attention is called to the possibility of confusion with glioma.

The first case was in a boy of two and one-half years, with a history of recurrent inflammation of the left eye, which at times was observed to show the shining appearance of a cat's eye. Examination showed the left eye blind, tension slightly raised, and slight ciliary redness. No pupillary reaction. Areas of clear fundus could be seen here and there, interspersed with grayish-white masses of flocculent material. Several groups of strikingly bright spots and patches (difficult to locate exactly) could be seen in various parts of the fundus. A hemorrhage was present in the lower outer part of the vitreous.

It was thought that the condition might possibly be one of glioma endophytum, and the eye was removed.

Pathologic examination showed a typical nodule lying in the depths of the retina, composed in the main of newly-formed fibrous tissue, colored red by von Giessen's stain, and permeated by an extensive system of cholesterol clefts. It contained numerous pigment particles, and enclosed one or more cavities of irregular shape, which often intercommunicated and were frequently more or less filled with the remains of disintegrating blood in the shape of débris, degenerate blood corpuscles, particles of pigment, network of fibrin, swollen leucocytes, and giant cells. Neither calcareous nor osseous changes were found. In many of the sections the choroid could be traced unaltered over the nodules, but in some the two structures appeared to be in organic connection.

For the rest, the angle of the anterior chamber was closed. The tissue of the iris was atrophic, with pigment clumps here and there, and had evidently been inflamed. The subcapsular epithelium extended around the lens.

The second case was a girl of four years, whose left eye had become blind. Tension plus one, and a complete detachment of the retina were observed. Because of the possibility of glioma, the eye was excised. Pathologic examination revealed complete retinal detachment, the subretinal space filled with a homogeneous coagulum containing "ghost cells," which also infiltrated the retina in places. Two kinds of nodules were found in the outer layers of the retina, both evidently formed from extravasation of blood. The first was a more or less homogeneous collection of fibrin or newly-formed connective tissue, while the second occurred as collections of pigmented tissue cells intermingled with new fibrous tissue and remains of blood corpuscles. These included numerous cholesterol cracks or clefts. For the most part the choroid was quite distinct from the retinal nodules, but in one small mass of reniform shape the two appeared to be in structural continuity through imperfections in the pigment epithelium. Many of the retinal vessels were thrombosed, and hyalin changes, leading to narrowing or displacement of the lumen, were not uncommon. The choroid showed no particular lesions. As regards the anterior half of the eyeball, the ciliary body and the iris were atrophic, and the uveal pigment could be seen to extend around the edge of the iris (ectropion uvae). The posterior pole of the lens was somewhat "moulded." The angle of the anterior chamber was closed.

Radiotherapy in glioma retinae. Axenfeld, Küpferle and Wiedersheim (*Klin. Monatsbl. für Augenheilk.*, vol. 54, p. 61, 1915) furnish the following reports.

The right eye of a child of 8 months was enucleated on 18th January,

1914, on account of glioma. This eye was already somewhat enlarged, the vitreous being almost filled by a typical growth with numerous Wintersteiner rosettes. The optic nerve was healthy at the point of section. In accordance with Axenfeld's custom, the second eye was examined ophthalmoscopically during the narcosis used for enucleation. At this time a prominent tumor was seen peripherally on the nasal side of the fundus. A more complete ophthalmoscopic examination was later made under narcosis. Three tumors were found—a large one to the nasal side and not delimitable anteriorly, one below the macula of about eight disc diameters, and a still smaller one two disc diameters above the disc. Clinically, fixation was uncertain. The X-radiations were carried on for a period of about ten months, being used both on the orbit of the enucleated eye and on the retained eye. During this period frequent ophthalmoscopic examinations were made under narcosis. There was gradual atrophy of all three growths. At the last examination under narcosis the site of the smallest tumor was represented by a delicate, scarcely visible discoloration of the retina; the growth below the macula was apparently entirely healed, and the largest mass had shrunk to such an extent that there was scarcely any perceptible prominence above the retinal level. The fixation of the eye was central and steady, and vision apparently good. The action of the radiotherapy had therefore been elective, destroying the tumor without causing discoverable change in the other tissues.

Experiments on rabbits were performed by Wiedersheim, who reports that large doses of properly filtered rays caused no demonstrable injury to the ocular interior of these animals, and particularly to the retina.

Küpferle deals with the theoretic and technical questions of intraocular radiotherapy. Some years ago Birch-Hirschfeld showed that unfiltered X-rays, in certain doses and at a focal distance from the skin of 10 cm., could produce severe changes in certain parts of the eye, especially the retina. But his observations were limited to unfiltered rays and rays of medium softness, as are now only used for superficial disease of the skin. The unsatisfactory results hitherto obtained with radiant treatment of intraocular tumors were probably also due to imperfect methods. It is now known that very small doses of the X-rays stimulate growth, whereas larger doses have an inhibitory effect. The result is materially affected not only by the quantity but by the quality of the rays. It has been found that the gamma rays of radioactive substances and the hard Röntgen rays are the ones which destroy and inhibit the growth of tumor tissue. The harder

the radiation is the less it is absorbed by the superficial epithelial layers. Aluminum has proved to be the best filter material: it not only cuts out the soft rays, but by its own complex secondary radiation increases the hardness of the rays which pass through. The most suitable thicknesses of it are 3, 4 and 5 mm. It is also necessary to modify the electric current in such a way as to produce the greatest possible hardness of radiation from the tube itself. In Axenfeld's patient the treatments, given at intervals of from two to fourteen days, were of from 8 to 32 minutes' duration; and the surface energy according to Kienböck's enumeration varied from 10 X to 35 X. The thickness of the aluminum filter was from 3 to 5 mm., and the focal distance from the skin almost always 22 cm.

Axenfeld urges that in every case of unilateral glioma of the retina the second eye should, without fail, be examined to its utmost periphery, under narcosis, if not otherwise practicable. If this is done, he is satisfied that the disease will show itself to be much more frequently bilateral than has previously been supposed. Further, every case of enucleation for glioma, even in the earliest stage, should be submitted to irradiation. Amaurotic eyes should be enucleated, but if enucleation is refused, or if relapses occur, radiotherapy should be attempted. For beginning glioma on the other hand, for glioma in the still seeing eye (naturally only seen by the physician in the second eye), the use of radiotherapy is not only justified but indicated.

Rex Duncan (*Am. Journ. Ophthalm.*, Oct., 1918) after employing radium in three cases of *retinal glioma* states that while the cases reported are too few to justify definite conclusions, in view of the frequency of recurrence and high mortality following surgical treatment alone, the results obtained in these, and similar cases, would seem to warrant the following conclusions: In early cases, immediate enucleation, followed by immediate prophylactic radium radiation, would prevent a high percentage of recurrences; in later cases, in which the nerve stump or orbital tissues are also involved, immediate enucleation, followed by proper radium treatment, should be employed; in recurrent cases, radium therapy is a most effective method of treatment.

O. Purtscher (*Cent. f. Prak. Aug.*, 39, Nov., 1915, p. 193) has reported the clinical history of a *glioma family of 11 children*, 6 boys and 5 girls, of parents with healthy eyes. The two youngest boys died of bilateral glioma. The two oldest sisters presented an unusually striking ophthalmoscopic aspect of the left eye, which the writer shows must be regarded as the product of regression of the glioma. Out of 3 children, 2 boys and a girl almost 3 years old, of

the second youngest sister the younger boy had advanced glioma of the left eye, from which he died without operation. The older boy showed, like his aunt, a most peculiar ophthalmoscopic condition, which also had to be considered as a glioma in a state of involution. Both cases of the latter type indicate the possibility of a spontaneous healing of glioma.

Paul D. Berrisford (*Roy. London Oph. Hosp. Rep.*, March, 1916) has given a valuable report of 41 cases of glioma retinae. He summarizes his studies of them as follows:

(1) Relative frequency. Taking the total number of new patients at the Royal London Ophthalmic Hospital during the last forty-two years the ratio of glioma retinae to other eye diseases is found to be 1 to 96,144, or slightly more than 0.01 per cent.

(2) Sex. In the series of 41 cases on which this paper is based there were 22 males and 17 females; in 2 cases the sex was not recorded. In reviewing the literature on this topic statistics show that glioma retinae occurs more often in males than in females, but the difference is too small to be worth considering.

(3) Eye affected. The right eye was affected alone in 16 cases, the left eye in 17 cases. There were 6 bilateral and 1 doubtful bilateral case. In one instance the eye involved was not recorded. The proportion of bilateral to unilateral cases is in this series 1 to 7, or 14.6 per cent. The usual figure quoted is 25 per cent., in accordance with Wintersteiner's report of 405 cases.

(4) The age of the patient when the growth was first observed. The tumor was in 3 cases first observed at birth, in 4 cases during the first three months of life, in 3 cases between the third and sixth months, in 2 cases between the sixth and twelfth months, in 6 cases during the second year of life, in 3 cases during the third year of life, in 4 cases during the fourth year of life, in 3 cases during the fifth year of life, and in 2 cases during the sixth year of life. Of 135 selected cases 41 per cent. showed evidence of the presence of glioma retinae during the first year of life.

Recoveries. In this series 9 patients may be considered as cured, three years having elapsed since the enucleation of the gliomatous eyes without signs of recurrence.

Fatal cases. There were 4 fatal cases, in 2 of which there were a considerable involvement of the optic nerve and an extension of the growth into the orbital tissues. In the other 2 cases the growth was bilateral, and in both instances the parents would not consent to double enucleation. It is noteworthy that of the 9 cases which have recovered in no one had the growth invaded the optic nerve as far as its cut

end. This shows the importance of cutting the nerve as far back in the orbit as possible.

Gliomata in shrunken eyes. The presence of glioma in a shrunken eye is a rare condition, only 20 cases having been hitherto recorded in ophthalmologic literature. The present series contains one case of this type.

Family history. While it is comparatively rare to find more than one member of a family affected by glioma retinae, there are only 2 instances to be found in literature where a child once affected with glioma retinae has grown up and has had children who developed the same disease. In the present paper the appearance of this disease in another child belonging to one of the above families (the Grover family) is reported for the first time, and the pedigree of this family is given in full.

No fresh cases of this kind have, however, been met with.

Frank E. Taylor and Norman B. B. Fleming (*Ophthal. Record*, p. 43, 1917) contributed a case of bilateral glioma of the retina with multiple metastases. The patient was a female child æt. 3 years, in whom an abnormality was noticed in the left eye 18 months previously. On admission, there was a fungating growth protruding between the lids of the left eye, keeping them separate. The mass was bathed with a thin, semi-purulent discharge. The right eye was much enlarged, and apparently proptosed, the iris fully dilated and stretched into a thin band at the limbus, the lens being in contact with the posterior aspect of the cornea. The growth was of lemon color. No reflex was obtainable ophthalmoscopically. Elmore Brewerton operated at once, performing exenteration of the orbit, with partial removal of the lids, afterwards suturing the wound. The right eye was very freely excised. The optic nerve was found to be involved, being surrounded by growth for half-an-inch behind the eye. A fortnight after discharge, there was a recurrence, half the size of a tennis ball, from which the patient died. She had shown little evidence of pain. Microscopically, the growths were found to be composed of closely-packed small round cells, with large deeply-staining nuclei. A few spindle-cells were also present. The body was much emaciated, and the metastases were extensively distributed.

Charles Maghy (*Brit. Journ. Ophthalm.*, Aug., 1919) records a remarkable and probably unique case of *bilateral glioma of the retina in a girl twenty years of age in which the second eye was excised after an interval of 18 years*. The patient was single, in good health, had a series of fits during the summer of 1913, two or three each week, for a period of three months. On Christmas day, 1913, her left vision

failed rather suddenly while at church and patient was led home. Four days later, the family doctor was consulted and attended patient at intervals until October the following year. The family history was negative.

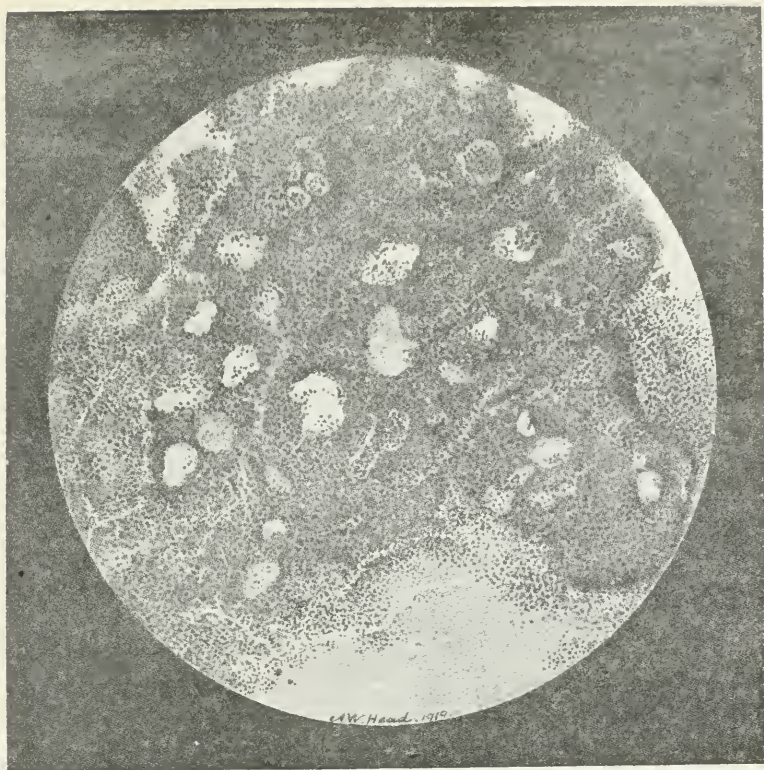
On admission October, 1914, the left eye was quiet, slight corneal haze present, but no "keratitis punctata" was seen. The anterior chamber was of normal depth and the aqueous clear. The pupil was circular and active. The iris, however, showed a few fine blood-vessels on its surface. The lens was opaque. Vision equalled hand movements and projection was quick and accurate. T. + 1. On October 9, J. Herbert Fisher performed a linear extraction under cocain. The following day the eye showed some edema of the cornea and the pupil was dilated. T. full. Eserin $\frac{1}{4}$ per cent. contracted the pupil, but the tension remained normal for a few days only, and on October 20, a posterior sclerotomy was performed. A few days later the nasal field was found to be defective, a deposit resembling "keratitis punctata" developed, the cornea became hazy, and the tension was again plus. In December, a whitish, granular deposit, which on microscopical examination showed cells resembling degenerated mononuclear leucocytes, settled to the bottom of the anterior chamber. Hemorrhage from the iris accompanied the paracentesis. Following a needling, the vision with a plus 12.00 D. sphere equalled 6/60 and with a plus 15.00 D. sphere, J.19. On March 9, 1915, the patient was discharged from the hospital, the vision now being reduced to the counting of fingers. Repeated operative measures failed to reduce the tension, but it was not until March, 1918, that the patient had severe pain. The eye was excised on May 17, 1918.

Right eye. The following is taken from the records relative to the patient's right eye. "Admitted to hospital, July 7, 1900, on account of trouble with her right eye. Anterior parts of eye normal, with the exception that the anterior chamber is shallower than in the left. By oblique illumination a three-lobed mass was seen lying far back in the vitreous cavity with blood-vessels coursing over same. No reflex present. T. + 1. Vision equalled P.L. Vitreous cavity nearly filled with a white flocculent growth. Anterior chamber almost obliterated. Lens yellow and misshapen. Posterior surface drawn back to a peak at point where retina passes back to optic nerve. Retina detached at seat of growth. Choroid in situ, optic nerve apparently not infiltrated. Macroscopical report. Eyeball shows exophytic growth. At one spot layers of retina seem to be involved. Growth seems to spring almost entirely from inner nuclear layer. Inner granular layer invaded, also ganglion cell and nerve fibre layers. Cells grouped around blood-vessels. No rings of cells. Little degeneration."

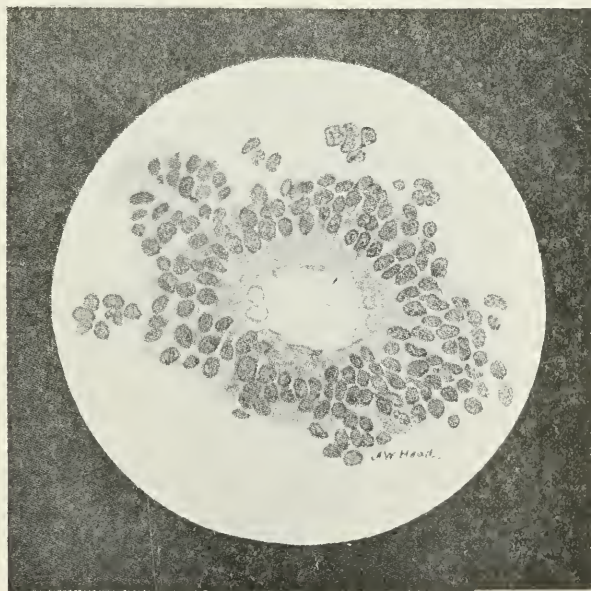
Left eye. Pathological report on eye excised May 17, 1918. Macroscopical. The left globe measured about 23 mm. by 22.5 mm. A staphyloma was present at the temporal side of the cornea, which extended backward about 6 mm. to 7 mm. The cornea showed a few fine nebulae peripherally, the central portion being quite clear. The iris appeared normal and the pupil was about 5 mm. in diameter and round, although slightly eccentric up and out. The aqueous was only faintly clouded. No lens present, but a strand of greyish tissue occupied its place. A grayish mass could be seen in the vitreous cavity. On section of the globe the vitreous was very fluid and contained a whitish deposit. The retina was not recognizable except at the anterior parts of the globe. The tumor extended forward to within a few mm. of the lens capsule, but did not completely fill the cavity.

Microscopical. Hematoxylin and eosin and Mallory's connective tissue stain. Cornea: This structure as a whole was thinned. The epithelium was absent in places, but otherwise was normal. Bowman's membrane was intact throughout. The stroma, although thinned, showed little evidence of inflammatory changes. Anterior chamber. The conformation of the angle was changed as the root of the iris was in contact with the posterior surface of the cornea. The cells at the angle stained faintly and were probably degenerated leucocytes. A few glioma cells were also present. Iris: This structure was more or less uniformly atrophic. On the posterior surface the pigment was heaped up into irregular patches at some places, while in others it was entirely missing, being attached to the lens capsule. Ciliary body: Contained glioma cells and was atrophic. Vitreous cavity: The growth as a whole was quite vascular and was composed chiefly of cells that stained deeply with hematoxylin. No pigment was to be seen throughout the growth; areas of cellular degeneration were occasionally found. The cells immediately surrounding the blood-vessels stained deeper than those situated peripherally, and at the extreme periphery of the so-called rosettes of Flexner and Wintersteiner beginning cell necrosis was in evidence. The retina at the posterior part of the globe was entirely destroyed by the growth. In the anterior parts it was invaded with glioma cells and was very atrophic. The choroid was also atrophied and in places was only indicated by a dark line. The optic nerve was not involved outside the globe.

The portion of the tumor that was extrabulbar, in contrast to the intrabulbar portion, showed pigment changes and did not stain as uniformly. The vascular spaces were also much less clearly defined. The rosette appearance, so common in glioma of the retina, was lacking.



General View of Tumor Showing Cells Arranged Around Vessels and Spaces. $\times 90$.



Showing Rosette of Wintersteiner. $\times 390$.
Glioma of the Retina in an Adult. (Maghy.)

The case is of interest on account of the period that elapsed between the excision of the two eyes, there being no case on record where the age of the patient exceeded 17 years. Fuchs mentions a case between 15 and 16 years of age (*Text-Book*, 5th Edition, p. 597).

In Lawford and Collins's series of sixty cases of glioma of the retina (*Ophth. Hosp. Reports*, Vol. XIII, p. 15), 6 to 7 years is given as the maximum age at the time of the excision. The literature covering 120 cases from this hospital does not show that a single case reached the age of 8 years.

The *American Encyclopedia of Ophthalmology*, Vol. VII, p. 5,583, states "Glioma is a disease of childhood, no true case having been found after the sixteenth year. Cases heretofore reported of greater age have been found to be either sarcomas of the choroid or pseudo-neuro-epitheliomata."

Wintersteiner mentions a case (*Das Neuro-epithelioma Retinæ*, 1897) in which the patient was 17 years of age, and the duration seven months.

"The patient has not had a recurrence in the orbit or metastasis elsewhere, so far as is known at this period, although thirteen months have elapsed since the second eye was excised."

Granuloma of the retina. See p. 5631, Vol. VII, of this *Encyclopedia*.

TUMORS OF THE OPTIC NERVE.

Under such headings as **Optic nerve, Cylindroma of the**, p. 9068, Vol. XII, and other captions that follow, this subject has already been discussed. See, in particular, **Optic nerve, Intradural tumors of**, p. 9075, Vol. XII; **Optic nerve, Sarcoma of the**, p. 9079; and **Optic nerve, Tumors of the**, p. 9081, where a classification of optic growths is furnished and a number of them described. To this matter the following examples are added.

W. Grauss (*Zeitschr. f. Augenheilk.*, Feb., 1912) reports the following case: An otherwise healthy man, aged 26, complained of failure of sight of the right eye for a few days. V = fingers at 4 mm., relative central scotoma, which later on became absolute. A red swelling with a smooth surface covered the entrance of the optic nerve and its vessels. The center of the tumor had a refraction of +5 D. The periphery of the fundus was emmetropic. Under the surface of the tumor fine vessels showed through. On pressure upon the eyeball the tumor grew pale and the vessels disappeared. It was surrounded by a ring of pigment. The adjacent retina was edematous and of a greenish-gray color. The vessels emerging at the margin of the

tumor, especially the veins, were compressed, and a few streaky hemorrhages were visible in the retina. Treatment with mercurial injections had no effect, and after four weeks the prominence had increased by 2 D. The writer diagnosed an encapsulated, soft, vascularized fibroma, or a sarcoma or myxosarcoma, and advised enucleation, remembering that in all five cases of tumors of the optic disk published the tumor was sarcoma. After an ineffectual tuberculin cure the enucleation was performed by Shieck, who reported that the anatomic-pathologic examination revealed an angiosarcoma.

Gilbert's (*Oph. Year-Book*, p. 324, 1916) patient with pseudoglioma and pseudotumor of the optic nerve was a girl aged 3½ years, who had had a previous fall on the occiput. The eye was enucleated on account of possible glioma. The specimen revealed no tumor but a total detachment of the retina, with a gelatinous exudate between it and the choroid. The optic nerve was transformed into glious tissue, which indicated a connection with an intracranial disease. Pattee's patient was a boy aged 3 years, with a typical picture of amaurotic cat's eye. Work found a neurological examination negative. A differential diagnosis between syphilis, tuberculosis and glioma was considered. A microscopic examination of the enucleated eye by Maynard demonstrated the presence of a neuroblastoma. Recurrence was detected two months after operation, one month later the socket was filled with the tumor.

The *Ophthalmic Year-Book*, 1909-1912, gives brief abstracts of many cases of tumor of the optic nerve. Among them is Lawford's (1909) case, one of primary, extra-dural tumor. The patient first noticed something wrong with the left eye when she was 34 years old, vision being then 6/9 partly. Four years later there was proptosis, restriction of upward and outward movement, no pain, retinal veins dilated and tortuous, and nerve entrance swollen, ill-defined and rather pale. Vision, light perception. A year after that the movements of the globe were greatly restricted, and there was no perception of light. The eyeball was removed with the tumor, which extended from the posterior part of the globe into the optic foramen. It was found to be an alveolar sarcoma, mainly outside the dural sheath. The nerve was completely atrophic. De Vries' case was one of endothelioma arising from the pial sheath. The optic nerve was atrophic, as was also the nerve fibre and ganglion-cell layer of the retina.

A comprehensive study of the nature of tumors of the optic nerve, with summaries of 182 cases included in the literature of the subject, is offered by Hudson (1912). He considers that an attempt should

be made at more scientific classification of these growths, and divides them into three groups.

The first class he would describe as a "degenerative gliomatosis, implying a generalized overgrowth of neuroglial tissue, of infiltrative character, dependent on some degenerative change in the tissues of unknown etiology." Of the cases tabulated by him, 118 belong to this class. They have been described under such widely varying names as sarcoma, glioma, neuroglioma, myxoma, fibroma, and neurofibromatosis. The tissues are characterized by the following cell-types: (1) cells with oval, well-staining nucleus, and a faintly granular cell body which is drawn out into a long, narrow fiber; (2) similar cells with thicker processes, which often have club-shaped extremities containing hyalin masses; (3) stellate cells with more or less numerous processes; and (4) cells with round or oval nucleus and coarsely granular cytoplasm. The cystic tumors may represent an extreme mucinous degeneration of the cell processes; while other tumors show a strong tendency to organization into more or less compact fibrillated material. Between these two extremes intermediate types occur, probably giving rise to the varied nomenclature. But the essential feature is an overgrowth of glial tissue. It is suggested that in some cases the unknown deleterious influence has been limited to the intervaginal space, which would account for localization of the growth in that region. Of these 118 cases, 75 per cent. developed exophthalmos in the first decade of life. In the great majority of those cases in which exact information is available, a defect of vision preceded the appearance of the exophthalmos. In many instances the degree of visual defect was out of all proportion to the ophthalmoscopic signs. In probably almost 50 per cent. of the cases removal of the growth was incomplete. Nevertheless, in no case was a local recurrence in the orbit recorded, and freedom from recurrence was noted for periods varying between one and twenty-four years. Where intra-cranial extension of the disease occurred, the neoplasm seems either to have remained stationary or to have progressed so slowly that the patient eventually succumbed to some other ailment.

Under the title of fibromatosis of the nerve sheath the author groups six tumors whose most characteristic feature is an enormous development of fibrous tissues, in five cases involving only the outer sheath of the nerve. The changes in the nerve itself were attributable to atrophy from pressure or interference with nutrition. In at least two of these cases exophthalmos preceded the visual defect by a con-

siderable interval of time, while in no case was the opposite relation observed.

A third, well-defined class is constituted by twenty-seven endothelial tumors of the nerve sheath, which were composed of masses of endothelial cells, supported by a connective tissue, which was usually scanty. These tumors probably arise from the endothelial cells of the arachnoid. They tend to lie in close contact with the eyeball, whereas the glial tumors of the first class commonly leave a pedicle of unthickened nerve lying between them and the globe. In these cases also failure of vision seems generally to develop after distinct tumor formation has been evidenced by exophthalmos. In marked contrast with the gliomatosis class, these tumors show decided tendency to invade surrounding tissues. Yet local recurrence was only recorded in three of the twenty-four cases operated upon.

Griffith (1912) reports three cases of optic nerve tumor. The first, which he calls a lymphangioma, consisted of widely dilated lymphatics and lymph spaces in a matrix of vascular fibrous tissue. The second was a soft mass of tissue permeating the substance of the nerve so as to be indistinguishable from it. On microscopic examination it had a general gliomatous structure; but there were other areas resembling round-cell sarcoma. The third growth, defined as an extradural endothelioma, surrounded the nerve, but may have had its origin from other structures in the orbit. As endothelioma, also, Benson reports an extradural growth arising from the dural sheath of the nerve. In Sweet's cases of intradural growth, no trace of the optic nerve could be discovered macroscopically; and the tumor was made up of a cellular reticulum and innumerable blood vessels and spaces.

In the case of melanosarcoma of the optic disc reported by Kojanagi no normal nerve fibers remained. The presence in the fibrous network of a homogeneous gelatinous material led the author to diagnose the growth as glioma, and he believes that some cases hitherto described as myxosarcoma have belonged to the same category. In the tumor reported by Lewis (1912) as glioma of the optic nerve, the diagnosis was apparently based in the main on the presence of a translucent jelly-like substance between membranous septa.

In Komoto's case of tubercle of the optic nerve, the eye was enucleated. Accompanying a fever the eye became red. One month later there were diffuse opacities of the cornea, and posterior synechia. Behind the clear lens gray folds were seen. In section there was total funnel-shaped detachment of the retina with a mass occupying

the nerve head and neighboring retina. The choroid and peripheral parts of the retina were infiltrated with leukocytes and other cells but there were no giant cells in these situations. Komoto divides the reported cases into three classes: 1. Optic neuritis with partial swelling. 2. Distinct swelling of the disc spreading partly into the surrounding retina, with marked choroidal or retinal complications or glaucoma. 3. A mass at the papilla with detachment of the retina leading to secondary glaucoma and inflammatory changes in the iris which may be complicated with recurring hyphema.

Jakobs records the clinical and microscopic history of a case of optic tubercle. The patient was a male 17 years of age. Sight had been poor in the left eye for two years. Both eyes showed tuberculosis of the tear sacs with involvement of the conjunctiva in the left eye. A gray-white nodular mass projected from the papilla into the vitreous. In the extreme upper periphery of the fundus there were small grayish flecks in the retina. There was tuberculosis of the pharynx and larynx. Wassermann reaction was negative. The growth increased slowly and about one year later iridocyclitis developed and the eye was enucleated. The mass proved to be a large solitary tubercle of the papilla, optic nerve and retina with a slight degree of involvement of the uvea, ciliary body and root of the iris. Bacilli were not found.

Robert Sattler (*Arch. of Ophth.*, Jan., 1913) records the extirpation of the tumor in two cases of optic fibrosarcoma. Case I was first removed by resecting the outer wall of the orbit (Kroenlein). Five days later, it was necessary to enucleate the eyeball. Examination showed the neoplasm to be a fibro-sarcoma, apparently having its origin in the dura mater. Two years after the operation, the health of the patient was favorable.

Case II was an intra-dural fibro-sarcoma of the optic nerve occurring in a boy aged four years. A progressive exophthalmos, of five months' duration, was present with optic atrophy. The tumor was removed as an encapsulated mass. Later, the eye was enucleated. Fourteen months later, the patient was in good health.

Oloff (*Oph. Year-Book*, 1916) reports the rare condition of a primary sarcoma of the optic disk. The patient, a man aged 22 years, who had been under observation for eighteen months, was otherwise healthy. The sectioned eye showed a tumor projecting 3 mm. One year following enucleation there was no evidence of metastasis.

Cyst of the optic nerve. As an introduction to this subheading see p. 9068, Vol. XII of this *Encyclopedia*.

Wm. C. Bane (*Am. Journ. Ophthalm.*, Jan., 1918) had a good result in his patient with cyst of the dural sheath of the optic nerve. A lad, aged 6 years, at the time of his first visit showed vision with the left eye almost nil, a pearl-white disc and a hyperopia of 3 D. Two and a half years later the eye ball protruded 5 mm. forward, downward and inward. The hyperopia had increased to 6 D. A tentative diagnosis of fibroma was made. The X-ray did not reveal any evidence of sinus involvement or solid tumor. The mass, together with a section of the optic nerve, was removed through a conjunctival incision 30 mm. long and 5 mm. external to the cornea. During the operation the cyst collapsed, permitting the escape of a clear fluid. Finnoff's pathologic findings showed the optic nerve fibers atrophic; the pial sheath of a honeycombed appearance; and the dural sheath, greatly thickened; the endothelium in the anterior portion filling the space between the pia and dura. Posteriorly, the cells gradually thinned.

Eleonskaia reports the case of a tumor of the optic nerve in a boy, aged 6 years, of three years' duration, apparently of benign character, in which all the topographic relations of the nerve were preserved, but considerably increased in their dimensions. There was a polymorphic character in the microscopic structure, and in the central parts, corresponding to the nerve trunk, a marked resemblance to glioma and gliosarcoma. There was also some degeneration and edema of tissue.

A psammoma of the sheath of the optic nerve was observed by Ferro. In Shiosi's two cases of intradural tumor of the optic nerve, histologically, one was a glioma while the other was a myxoma.

Edmondson reports a lipoma of the optic nerve successfully removed by the Krönlein operation.

Osteoma of the optic disk. E. C. Demaria (*Boletín de la Sociedad de Oftalmología de Buenos Aires*, third year, p. 49) reports an extraneous formation of bone in the optic disk. The eye was of the familiar atrophic, painful type, and had been removed from a woman of seventy years. The microscopic findings were those usually occurring with chronic iridocyclitis with subsequent atrophy and ossification. The bony tissue replacing the choroid, instead of terminating in a bony ring in the vicinity of the optic disc, extended as a ring into the

structure of the disc itself. The bony structure was completely typical, containing a moderate quantity of medulla, Haversian canals, and osteoblasts.

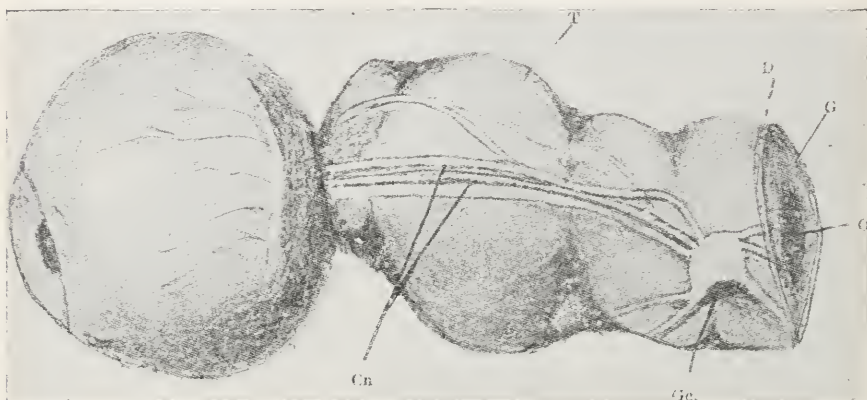


Fig. 1.

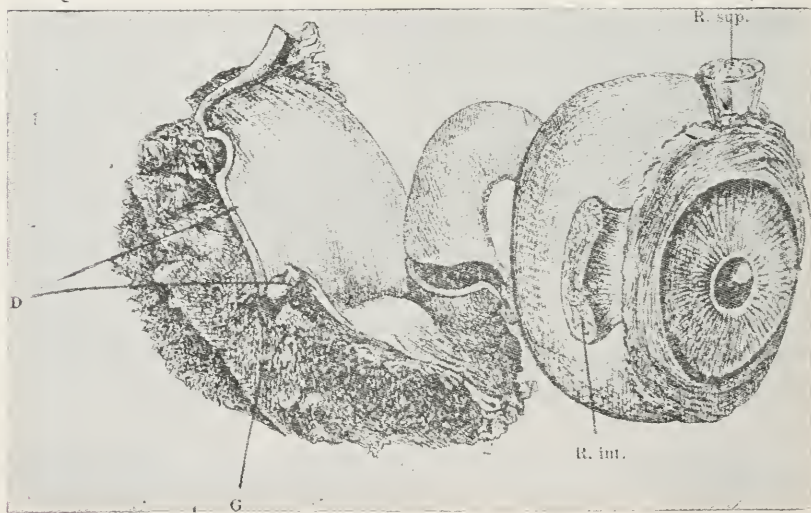


Fig. 2.

Fig. 1. Diffuse Sarcoma of the Optic Nerve.

Fig. 2. Stalked Sarcoma of the Optic Nerve. (Vossius.)

Chas. R. Heed (*Trans. Am. Ophth. Soc.*, 1915) reports a case of primary intradural tumor of the optic nerve. The patient was a girl, aged eleven years. One year before, shortly after vaccination, the left eye became prominent. The general health of the child had al-

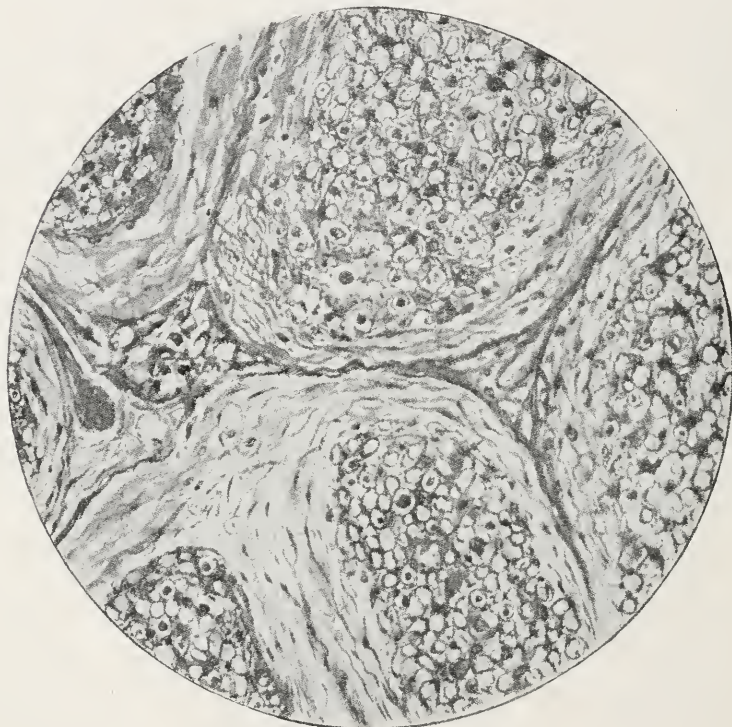
ways been good; never had the common diseases of childhood. The examination showed the eye to be proptosed approximately 2 cm. Upward rotations were absent, but there was slight rotation outward and fairly good below and inward. The disc was atrophic, and numerous white spots of absorption appeared throughout the fundus, with a star-shaped formation in the macular region. An exploratory incision disclosed a large tumor extending back to the optic foramen and so completely filling the orbit that removal of the eyeball was considered advisable.

de Schweinitz gives (*Trans. Am. Ophth. Soc.*, 1915) the final history of an intradural tumor (psammoendothelioma) of the optic nerve. This was in a girl, aged fourteen, with slowly increasing exophthalmos, which had existed for a couple of years. The optic nerve was entirely atrophic, without signs of preceding neuritis. For a period of time operation was declined, but on account of ever-increasing deep-seated orbital pain, was finally permitted. It was impossible to remove the growth without the eyeball, to which it was densely attached. It was a pear-shaped mass, and presented the histologic picture of a psammomatous endothelioma. The sections illustrate the development of the psammoma bodies and their relation to small blood-vessels. In less than half a year there was recurrence of the growth in the orbit, which became densely packed with hard, almost cartilaginous, masses. Complete evisceration was performed, and the same character of growth as previously described was found. Recently, although there appears to be no definite recurrence within the orbital cavity except in one spot, the patient has had many attacks of explosive vomiting, suggesting the probability of recurrence within the cranial cavity.

E. C. Ellett (*Annals of Ophthalm.*, July, 1916) reports a case, with full histologic details, of intradural tumor of the optic nerve in a negro girl, aged three years. She was admitted on account of unilateral exophthalmos affecting the right eye. The family history presented no points that would seem to have any bearing on the patient's present condition, and there was no tendency to tumors of any sort in any of the child's antecedents. The present condition was of a few months' duration and of gradual onset, being attributed by the parents to a blow on the eye which the child received by stepping on a hoop lying on the ground so that it flew up and struck the region of the eye. As there was no evidence of any cut on the eye or neighboring skin, it is doubtful if this injury was sufficiently serious to cause any trouble.

The only thing apparently wrong was the proptosis; this was quite

marked and measured twenty-one millimeters with the exophthalmometer as compared with eleven millimeters in the other eye. Besides protruding forward the eye was pressed a little downward, and while motion laterally was well preserved, vertical motion was entirely lost. The pupil was slightly dilated and did not respond to light. Externally the eye was entirely normal, as were the conjunctiva and lids. No evidence of light perception could be elicited, and



Intradural Optic Tumor. (Ellett.)

• [Reproduced in black and white to show tumor structure.]

several examinations led to the conclusion that the eye was blind. Nothing could be felt in the orbit by palpation, and on account of the proptosis and the fact that the tissues were quite soft, this manipulation was easily and satisfactorily carried out. The eye-ground was normal, and especial mention should be made of the fact that the nerve head was normal in appearance. Roentgen-ray examinations and careful examinations of the nose were all negative, as was the general physical examination, urine and blood.

By exclusion the case was diagnosed as some sort of orbital tumor; probably a tumor of the optic nerve; so enucleation of the eye and tumor was done.

As soon as the muscles were divided and the nerve located, it was seen that this structure was materially enlarged, and in following it backward, the enlargement persisted until the optic foramen was reached. The nerve was cut level with the foramen, and apparently



Intradural Optic Tumor. (Ellett.)

[Reproduced in black and white to show the structure of the growth.]

the intracanalicular part of the nerve was affected by the same process which caused the enlargement of the orbital portion. Recovery was uneventful.

The enlargement of the nerve affected the whole of the orbital portion. The enlargement measured nearly three centimeters in length and one-half centimeter in thickness. It was hardened in formalin and imbedded in paraffin and cut. The following report was made by H. T. Brooks: "Microscopic study of specimen of tissue from

tumor of optic nerve showed the following histologic structure: The principal finding was a hyperplasia of tissue resembling—by the use of ordinary stains—connective tissue. This increase was present in and about epineurium, perineurium and to a less extent in the endoneurium. In other words, it was general throughout the portion of nerve trunk examined, and not localized. By the use of selective stains this hyperplastic tissue proved to be glia tissue, chiefly neuroglia



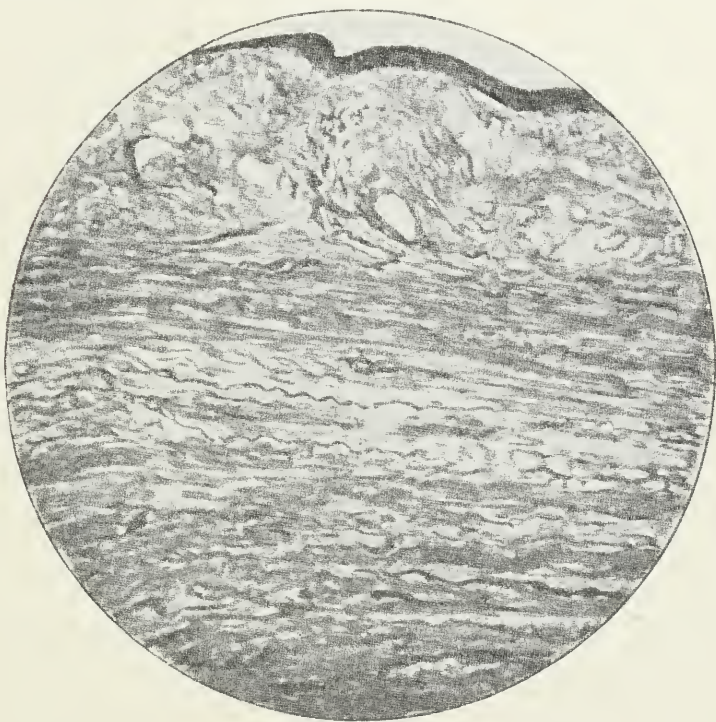
Intradural Optic Tumor. (Ellett.)

[Reproduced in black and white to show the neoplastic structure only.]

fibrils with relatively few glia cells. Diagnosis: Glioma, or a gliosis of the optic nerve. In this specimen the excess of neuroglia fibrils and relatively few neuroglia cells speaks for very slow growth. It is, therefore, in my opinion, not malignant. In order to determine absolutely the character of this hyperplastic tissue, the following specific stains were employed: 1. Van Gieson's stain for connective tissue. 2. Mallory's anilin-blue stain. 3. Phosphotungstic acid hematoxylin for neuroglia fibrils."

Clinical features of this condition to which attention might be called, are the early age of its incidence (Parsons thinks they are probably congenital), the slow growth, slight malignancy and absence of metastases. According to Byers, the intracranial prolongation of the disease is usual.

Nothing can be done in the way of treatment except removal of the tumor, which often means removal of the eye as well. An at-



Intradural Optic Tumor. (Ellett.)

[Reproduced in black and white to show the tumor structure.]

tempt to remove the tumor alone can be made by means of the Krönlein operation, or what Byers advises, the Knapp operation, of removal through a conjunctival incision, with canthotomy and temporary division of the rectus externus.

E. C. Ellett (*Trans. Sec. Ophthalmology*, June, 1916) has reported, also, a *primary intradural tumor of the optic nerve* in a negro girl, aged 15. She came November, 1915, complaining that the right eye had protruded for five years and was blind. There was no history of

trauma, and the date of the beginning of the protrusion of the eye, as well as of the beginning of the failure of vision, was not definitely ascertained.

The right eye was prominent and turned inward and upward. Motion was preserved except outward. The proptosis measured 25 mm. with the exophthalmometer, as compared to 15 mm. in the left eye. The pupil was dilated and fixed and the eye was blind, but the external appearances were normal in every way. There were post-neuritic atrophy of the optic nerve and some tortuosity of the veins; otherwise the eyeground was normal. It should be especially noted that there was no attenuation of the vessels. The left eye was normal in every respect. The child's general health was excellent. There was no history of tumors in the family, no abnormality of the nose or accessory sinuses, and no pulsation to be heard or felt. On palpation the fingers passed easily into the orbit below and to the outer side of the ball, and a smooth movable mass, about the size of the eyeball, could be felt.

A diagnosis of tumor of the optic nerve was made, and operation under general anesthesia performed, November 17. A vertical incision was made through the conjunctiva near the limbus to the outer side of the cornea, and the external rectus muscle exposed and divided. By blunt dissection the tissues were pushed back from the tumor, which was found to be an enlargement of the optic nerve, beginning about 10 mm. back of the globe. The nerve was divided in front of the tumor and the ball displaced upward and inward. All the tissue being separated from the tumor by blunt dissection, an attempt was made to encircle it with a snare, with the idea that it lessened in size as the optic canal was approached and the wire would glide backward to the farthest possible point. As this did not seem to be taking place, the snare was removed and the tumor cut off as far back as possible with curved scissors. It was certain from the inspection of the tumor that not all of the tumor was removed, but that there was a prolongation into the optic canal, if not into the cranial cavity. The finger introduced into the space left by the tumor did not feel any mass, and the apex of the orbit was in all respects exactly similar to what exists after an ordinary enucleation, this being verified by experienced observers among those present at the operation. The hemorrhage was slight and readily controlled by pressure. The cavity was wiped out with tincture of iodine, the cut ends of the external rectus muscle united, a few sutures put in the conjunctival incision, and a pressure bandage applied. During the operation care was taken to avoid pressure on the eyeball.

The next day there was some discoloration and protrusion from bleeding into the tissues of the orbit, but the lids covered the ball and the cornea was clear. The protrusion subsided in a week, when motion was found to be limited. December 1, the exophthalmometer read 15 mm. in each eye. There was complete paralysis of the muscles supplied by the right third nerve, motion outward being preserved.

December 21, the paralysis was much better.

The changes in the eyeground were very interesting. November 27, there was edema of the whole central region of the retina and a



Intradural Optic Tumor. The large end is the posterior end and shows that complete removal of the tumor was not accomplished. (Ellett.)

cherry-red spot at the macula. The vessels were normal, except that an artery above the macula showed a broken blood current. November 29, the edema was more marked, extending to the nasal side of the disk. Pressure on the eye did not cause pulsation of the vessels, but readily emptied them of blood.

December 21, the edema was gone. In the macular region a few fine white dots and lines were seen. Near the disk, especially upward, was a deposit of black pigment dots on a pale-yellowish background. The pigment was also being deposited on the disk, giving an appearance like ashes thickly sprinkled on snow.

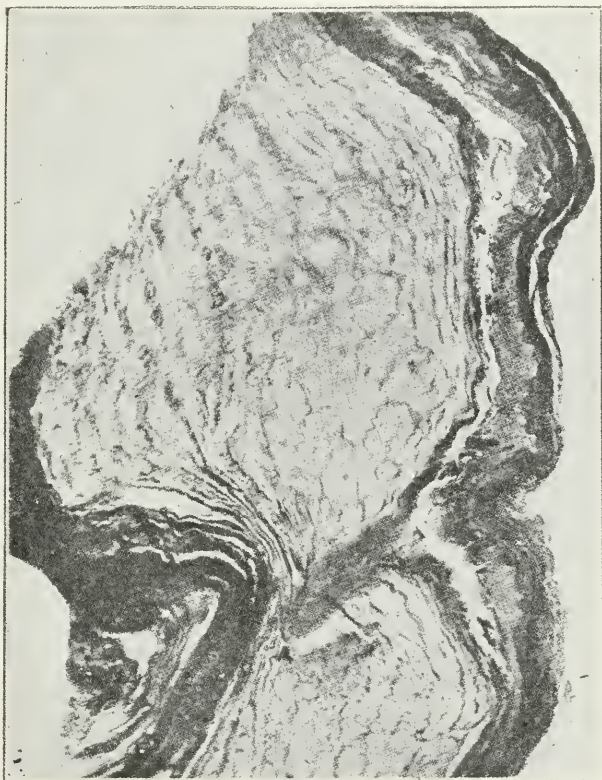
Jan. 16, 1916, there was more pigment deposit, almost covering the disk. The vessels were slightly attenuated, especially the arteries.

The tumor was smooth, tense and cystic to the touch, and measured 3.5 by 2.5 cm. On section, the center was found to be decidedly softer than the periphery, but it was not fluid. There were several small brownish areas, apparently due to capillary hemorrhages. Tests for mucin were negative, and did not therefore indicate a myxomatous change. The growth was hardened in alcohol, and cross-sections made of the nerve in front of the growth, longitudinal sections through the nerve and the front part of the growth, longitudinal sections of the posterior part of the growth, and cross-sections about the center. The size of the growth made it undesirable to try to cut it in one piece longitudinally. Sections were stained with hematoxylin-eosin, Van Gieson's stain, Mallory's anilin-blue, and phosphotungstic acid hematoxylin.

The whole tumor was surrounded by a dense fibrous capsule, continuous with the dural sheath of the nerve anteriorly. The subdural space could be made out, as well as the pial sheath, and none of these structures showed much departure from the normal. The longitudinal sections of the nerve and anterior portion of the growth showed that not all of the nerve fibres passed into the tumor, but many of them ended at a point where the sheaths made a sort of hour-glass contraction (See the figure). Serial sections were not made, so that it cannot be said that all the nerve fibers terminated at this point; but if any persisted, it was a mere thread. No trace of the central vessels could be found in the lumen of the hour-glass figure which the dural sheath assumed at this point, which was about 10 mm. behind the globe. It would seem, therefore, that the direct retinal circulation was interfered with before the operation was performed. Back of this hour-glass contraction the dural cavity enlarged rapidly and widely. At first the contents of the cavity were the nerve fibers, slightly altered; but soon a dense infiltration with the tumor cells took place, and the nerve fibers were quickly replaced by the tissue of the tumor. The farther back one went the more completely did the tissue lose all resemblance to optic nerve, the only part recognizable being the sheaths and connective tissue septa, and a small bundle of tissue, resembling nerve fibers, close to the sheath at one side.

Histologic study of the various sections of different portions of the tumor showed, in the undegenerated and better stained areas, the presence of many spherical cells with well stained spherical nuclei, surrounded by very little cytoplasm. These cells, morphologically, appeared to be glia cells. They were found diffusely scattered throughout the specimen. Interlacing in various directions were fibrils, which according to differential stains (phosphotungstic acid hematoxylin)

were neuroglia fibrils. This, however, could not be determined definitely, as the differential stains were not clear, owing perhaps to imperfect fixation. Many vascular channels with large lumina were present. In addition there were present areas of degeneration, and tissue elements, in a state of necrobiosis, the exact histologic structure of which it was impossible to determine.



Section of Nerve and Intradural Tumor, $\times 24$. The upper half of the picture represents the nerve. The constriction of the sheath, at which point most of the nerve fibers end, is well shown. (Ellett.)

A diagnosis was made of a moderately slow growing glioma, perhaps, better, fibroglioma (the "fibro" here referring to, or indicating, neuroglia fibrils, and not connective tissue fibrils). Owing to the presence of many vascular channels with wide lumina in the specimen, the diagnosis "telangiectatic glioma" may be more accurately applied.

G. Mansilla (*Siglo. med.*, 1917, lxiv, 979) reports a case of sarcoma of the right optic nerve.

A woman of sixty-three years showed exophthalmia, immovability of the right eye, and atrophic optic neuritis. These symptoms suggested a tumor of the orbital fundus. The Wassermann reaction was negative. Evisceration of the cavity was decided on and carried out under chloroform anesthesia.

On dissecting the lids, the fingers were inserted into the orbital cavity and discovered a rounded mass behind the eye-ball which



Intradural Optic Tumor, $\times 38$. Neither nerve fibers nor vessels pass through the constriction. (Ellett.)

occupied the orbital fundus and was adherent to the posterior pole. The nerve was sectioned and the eyeball separated and the new-growth and all orbital contents removed. The cavity was then curetted, cauterized and filled with a gauze tampon. The woman recovered completely.

The tumor, which was situated in the posterior part of the eyeball and in contact with it and the optic nerve, was microscopically examined and pronounced a fibrosarcoma. Pulido mentions another case in a child two years old.

TUMORS OF THE ORBIT.

Not only is the general subject of orbital tumors discussed, and these neoplasms fully classified, on p. 9187, Vol. XII of this *Encyclopedia*, but under individual captions, such as **Orbit**, **Carcinoma of**, the various new-growths found in the cavity of the orbit are also described and illustrated.

The reader is also referred, in this connection, to the other **Orbit** and **Orbital** rubrics. See, also, **Orbit**, **Operations on the**, p. 9155, Vol. XII.

To this information is added new material, as follows:

Arnold Knapp (*Archives of Ophthalm.*, p. 335, 1916; abst. in *Br. Journ. of Ophthalm.*, p. 263, 1917) reports the successful removal by a Krönlein operation of a (probable) *hemangioma of the orbit*. The patient, aged nine years, had suffered for a year from a slowly increasing prominence of the right eye. The eye was pushed straight forward in the axis of the orbit; the mobility of the eyeball was normal; no tumor could be found in the orbit; but sight was reduced to perception of light in the extreme temporal field, owing to a neuritic atrophy of the optic disc.

Krönlein's operation was performed and a bluish mass extending from the eyeball to the apex of the orbit was removed, the eyeball being left in place. An infection, apparently localized to the subcutaneous tissue, followed the operation, but it rapidly subsided and the patient made a good recovery. Finally, except for a dilated pupil, the eye looked perfectly normal. The optic nerve was completely white; some of the retinal vessels were narrow to the point of obliteration; there were atrophic and pigmentary changes in the region of the macula and on the nasal side of the optic disc.

The excised part of the optic nerve and tumor consisted of an irregular, cylindrical-shaped mass, 3 mm. long, by 2 cm. wide at its broadest part, entirely surrounded by a connective tissue capsule, which represented the extended dural sheath. The microscopical appearance of the growth suggested a hemangioma.

In commenting upon the foregoing case, Knapp draws attention to the changes in retinal circulation which occur. For example, in his case, notwithstanding complete division of the optic nerve and its blood-vessels, the retinal arteries and veins were of normal size for at least three weeks after operation, although subsequently some of them became narrow and obliterated. It has been shown by Schlodtmann that the changes in the ophthalmic picture of the retinal circulation depend upon whether a collateral circulation has been

established or not. He also draws attention to the oftentimes incomplete removal of these tumors of the optic nerve, which, according to Hudson, occurs in no less than 50 per cent. of the cases. Thus, in his own case, the tumor was not limited to the apex of the orbit, and had, without doubt, extended into the cranial portion of the optic nerve. In connection with the general impression that these tumors are almost benign, it is significant that not a single instance of orbital recurrence has been recorded. As X-rays seem to possess a distinct effect on the growth of gliomatous tissue (Axenfeld), Knapp enquires whether the systematic use of X-rays should not constitute a part of the treatment of these cases.

Carcinoma of the orbit. Arnold Lawson (*Ophth. Review*, p. 223, July, 1910) reports a case of secondary contracting scirrhus of the orbit.

In this case, three years before, the right mamma was removed for scirrhus of the retracting type, and the breast had been noticed to be undergoing cicatricial contraction for six years. About ten months before it was noticed that the right eye was becoming fixed, and the upper lid began to droop, but there was never any pain. The vision was $\frac{4}{60}$, and the fundus was very indistinctly seen. At the time of the report there was great retraction of the upper lid and eye, the lid drooped completely, and there was total loss of voluntary movement, except slight lateral movements; the lower lid was also fixed, but not retracted. There was a hard, elastic resistance felt on pressure through the lower lid, evidently due to a swelling in the orbital cavity, and it suggested some deep cicatricial contraction in the orbit pulling both the lids and the eye backward. The patient's general health was quite satisfactory, and there was no loss of flesh.

George S. Crampton, (*Trans. Coll. Phys. Phila.*, Oct. 16, 1913) gives the history of an orbital adeno-carcinoma originating in the lachrymal gland. The patient was a woman, aged forty-nine years, who had always been apparently healthy until five months ago, when diplopia was noticed, and the following month the right eye became more prominent than the left, and there was ptosis of the upper lid. Gradually the eye was thrust forward to the nasal side and downward, until the ptosis measured 10 mm. The cornea remained clear, the pupil active, and the fundus apparently normal. Free excursion, except outwardly, proved that there was but little if any involvement of the muscle cone. On raising the lid, the apparently normal accessory gland came forward, but the gland itself could not be uncovered. A narrow, dense growth extended forward 5 mm. beneath the upper, outer orbital wall. This mass had never been tender or painful. The

vision was reduced to 6/60, while that of the left eye was 6/6. As there were several small tumors in the scalp, and a large one 3 c.m. in diameter in the right axilla, the latter was removed as a diagnostic aid, and proved to be a fibroma.

Later, the orbital tumor proved to be an adeno-carcinoma originating in the lachrymal gland.

Snell (1909) reports a case of cancer of the orbit in which the disease seemed to have started in the lid, probably from a Meibomian gland. The tumor grew slowly for ten years to the size of a kidney bean, when it was removed. Eight months later, when the patient was first seen, recurrence had been noticed six weeks, and the lump was the size of a walnut. It was removed with a section of the lid, and a portion extending into the orbit. In six months there was a recurrence the size of a marble. The orbit was emptied. But the growth had recurred and the patient died a little over two years later. Van Duyse reports a case of orbital growth that appeared to start in the perivascular endothelium. Parts of the tumor were myxomatous, others cartilaginous and even bony. The patient was a man of 25, who had been wounded in the brow when 18 years old, and had noted displacement of the eye for two years.

Pooley reports a case in a man of 30 where the growth had been noticed under the brow for a year. A smaller growth had recently appeared on the temple. The growth was removed with some difficulty, being devoid of capsule and very firmly adherent to the periosteum. The operation was through an incision along the orbital edge and extended into the temple. In three months there was a relapse. Removal was again tried without enucleating the eye. But a growth in the temple was not disturbed. The patient died three months later, apparently with meningitis. The microscopic examination showed a carcinoma which had probably originated in the lachrymal gland. Reis reports a case of orbital carcinoma of three years' standing, in which the ulcer occupying the whole front of the orbit was filled with the larvæ of a species of fly, probably *lucilia*. Two hundred and forty of these larvæ, each measuring 12 or 14 millimeters in length, were removed with forceps.

Birch-Hirschfeld (*Arch. f. Ophth.*, 90, p. 299, 1915), observed a carcinoma of the orbit in a woman, aged 35, which, as the autopsy revealed, originated from the hypophysis, occupied the right temporal lobe, infiltrated the Gasserian ganglion and broke through the temporal bone into the temporal and masseter muscles. Without cerebral symptoms it had spread into the orbit through the orbital veins and was combined with inflammatory symptoms, which characterized the clin-

ical aspect until exenteration. The violent pain, from which the patient was suffering, was due to compression of the Gasserian ganglion by the tumor. The intermittent increase of exophthalmus was caused by disturbances of circulation from the propagation of the tumor cells in the orbital veins.

At the nasal side of the choroid several small nodules of tumor were found in the interior of a larger vessel, while the corresponding interstitial tissue showed considerable infiltration. The central retinal vein was very much engorged, apparently from a nodule of the tumor on the central vein at its exit from the optic nerve or in a vein in the direct surroundings.

Endothelioma of the orbit. This neoplasm is described on p. 4312, Vol. VI of this *Encyclopedia*. A case is fully reported by C. A. Veasey (*Trans. Am. Ophth. Soc.*, 1902). H. R. P., married, a male, aged 35 years, is a chemist by occupation. According to the patient's statement his mother died from "cancer of the tongue." His father had an enlargement on the cheek bone, but as it caused him no annoyance nothing was ever done for it. One brother died of pulmonary tuberculosis. The patient is tall and slender, his general health being good. Twelve years before the examination a small growth about the size of a green-pea was observed beneath the left upper eyelid at the external portion of the orbit, and in front of the location of the lachrymal gland. The size of this growth slowly increased until it became as large as a walnut. At this time he consulted some oculist at a hospital dispensary, where the condition was diagnosed as a prolapsed lachrymal gland.

Examination showed a kidney-shaped growth, situated beneath the outer third of the left orbital ridge, which was mobile from side to side, but apparently having deep attachments in the orbital cavity. The eyeball was pushed slightly toward the nose and downward, and there was some impairment of the upward movement. No ophthalmoscopic change was found, and the vision of each eye was normal. During the year preceding this examination the growth of the tumor had been much more rapid than before.

Extirpation was advised, and as the patient refused to have employed any general or local anesthetic, the tumor was dissected out without their use through an incision along the orbital ridge in the outer third of the lid. Very little difficulty was experienced in its removal except that the point of attachment was deep in the orbital cavity, from which it had to be divided with scissors. There has been no recurrence of the growth. The following is the pathological report.

"Macroscopical examination showed the growth to be kidney-shaped,

measuring $2\frac{1}{2}$ centimeters in length, and from 1 to $1\frac{1}{2}$ centimeters in width. It was hardened in a three-per-cent. solution of formalin, and was firm in consistency, cutting with little resistance. The outer surface is smooth and of a slate color, with grayish mottling. The inside surfaces present a granular appearance, one-half of these surfaces being dark-gray with blackish, yellowish, and brownish mottling, while the remainder is light-gray in color. If pressure is brought to bear upon the latter half a grayish gelatinous material exudes, giving to the surface a honeycomb appearance. In the dark-gray half of the inside surfaces are three black areas containing gelatinous material, each measuring approximately two millimeters in diameter, two of these areas being partially surrounded with a narrow rim of grayish, translucent, jelly-like substance. The mass is completely encapsulated. After dehydrating in alcohol and embedding in paraffin the sections



Endothelioma of the Orbit. Macroscopical appearance of incised surface. The growth was half the size of the reproduction. (Veasey.)

were stained with hematoxylin and eosin, picric acid, toluidin blue, by Van Gieson's method and for hyalin material.

"Sections made from the light-gray half of the mass are covered on three sides by a layer of fibrous and muscle tissue, the width of the layer varying from one to two millimeters in thickness. It contains areas of rhexis, and scattered through it is a small amount of blood pigment. It also contains a few small round connective tissue cells and a number of large cells that take eosin intensely, but do not take any basic stain. At one end of the growth there is an area of gland structure in the fibrous layer, but between this and the tumor proper the capsule is found unbroken. The gland structure presents the ordinary appearance of normal lachrymal gland.

"Within the capsule the structure is composed of fibrous and muscle tissue and finely reticulated network that stains faintly with the basic dyes. In this structure are what appear to be giant cells, with a low magnification, but with a high magnification it is found

that they consist of a number of cells lying very close together. Their nuclei stain intensely with the basic dyes, while the protoplasm stains with the acid dyes. In a number of the cell clusters there is a faintly basophilic intercellular substance; here the nuclei do not stain so intensely, and the protoplasm is granular and basophilic in character. Throughout the reticulated structure there is also found another type of cell, varying in size from 7 to 20 micromillimeters in diameter, some



Endothelioma of the Orbit. Microscopical appearance showing at A, extreme margin of capsule; B, columns of endothelial cells; C, distended lymph spaces containing more or less granular acidophilic material. (Technique: Fixed in formalin, paraffin, hematoxylin and Van Giesen. Obj., B. and L., $\frac{1}{8}$ in., oc. 1 in.) (Veasey.)

being oval and others polyhedral in shape. Some of these cells do not take any basic stain, while others take it only faintly. Many anastomosing spindle and stellate cells are also found.

“In the dark-gray portions of the growth the cellular elements are more conspicuous. In many of the cells the nuclei are oblong, resembling the nuclei of muscle fibers, and varying from 8 to 15 micromillimeters in size, and staining intensely with the basic dyes. Some of them are surrounded by a rim of protoplasm, but the greater number appear to lie free in a basophilic granular material. In other situ-

ations the nuclei are either oval or spindle-shaped, but are all surrounded by a rim of protoplasm. Many of these nuclei contain vacuoles. Beside these, or near-by, are many spaces that are found to be occupied by a finely granular basophilic material, and are surrounded by a rim of basophilic material somewhat denser than that just referred to. There are also a few scattered arcs of hyaline cartilage undergoing myxomatous degeneration.

"Throughout the entire sections, but more marked in the periphery, are large areas that are composed of homogeneous acidophilic substance, and within these areas are grouped the cellular masses and mantle-like accumulations of endothelial cells. The microscopical examination, therefore, shows the growth to be a mixed tumor of endothelial origin similar to the mixed tumors of the parotid, to which the term endothelioma has been given; and the general grouping and arrangement of the cells is such as to justify the term used by Borrmann of lymphangio-endothelioma.

"Warthin (*Archives of Ophthalm.*, vol. xxx, 1901, p. 601) has reported a somewhat similar case having its origin in the lachrymal gland. The patient was a farmer, aged 45 years, whose family and personal history were negative. Five years before the growth was removed by Dr. Fleming Carrow there had been observed a bulging of the right eye, which increased gradually until there was marked exophthalmus. For two years preceding the removal of the growth the increase in size had been very slow. Vision in the right eye was 14-120; in the left 14-20. The eye of the affected side showed neuroretinitis and interstitial choroiditis. The tumor was about the size of a walnut, and was found well back in the orbit in the lachrymal gland region, but its exact relations to the gland could not be definitely determined. The tumor was shelled out of its bed, having no attachments, after which the exophthalmus disappeared, and the vision improved.

"The growth was found to possess a thick capsule of dense hyaline connective tissue, from which trabeculae of a similar tissue passed into the growth, giving it somewhat of a lobulated appearance. Between these trabeculae the appearance of the cut surface varied greatly, in areas being firm and quite like cartilage, in other portions translucent and jelly-like; other areas were yellowish, granular, and of a crumbling consistency. There were a few small reddish spots scattered over the surface. Immediately beneath the capsule the peripheral portion was pinkish, more homogeneous, and of softer consistency.

"The microscopical examination showed the growth to be a mixed tumor, containing myxomatous tissue, cartilage, cylindromatous and

sarcomatous areas, similar to the mixed tumors of the parotid. Just beneath the peripheral cellular zone there were scattered gland spaces lined with short columnar or cubical epithelium similar to that of the lachrymal gland. Many of these glands were very irregularly branched, some were cystic, and nearly all contained a colloid substance. A few of these glands were found also in the peripheral zone, but they were most numerous toward the center, where some areas presented the appearance of normal lachrymal gland structure. It is believed, therefore, that this growth had its origin from the lachrymal gland."

"In my own case," says Veasey, "the connection with the gland is not so apparent, for while the growth seemed to be so adherent to the gland that a small portion of the latter was excised in its removal, serial sections show that the capsule between the gland and the growth was unbroken. In addition, no gland spaces with epithelial lining are present.

"As pointed out by Warthin, the serous gland endotheliomata occur most frequently in early adult life, giving rise to slow-growing painless tumors, which are usually found encapsulated. There seems to be very little tendency to become malignant, and when they have been entirely removed their recurrence is seldom observed."

Dehognes (*Prac. Med. Series, Eye*, p. 215, 1917) gives account of an endothelioma of the orbit in a man, 30 years old, who presented himself with his left eye pushed nearly out of the orbit by a round, hard tumor in the upper internal angle, which was first noted some three years before. The vision was about lost. After a negative result from treatment it was decided to operate, and the tumor was found to be attached by a pedicle deep in the orbit; rapid, uneventful recovery and restoration of normal vision. A tenotomy of the inferior rectus, combined with an advancement of the superior rectus, was performed later with nearly perfect result. Under microscopic examination the tumor proved to be an endothelioma. Dehognes considers the case of special interest from the fact that a stretching of the optic nerve to such an extent and for so long a time did not result in its atrophy. There had been no return at the end of two years.

Van Duyse (1910) says that it is established that the orbit contains tumors of epithelial origin formed of epithelial elements and heretofore considered to be an endothelial type. Surrounded by a capsule their benign course contrasts with their carcinomatous nature. They correspond to the fibro-epithelial mixed embryological type of the salivary gland and palate described by Hinsberg. They are ectodermal in origin and preocular, springing from the layer of connective tissue which forms the major part of the orbital walls.

Dupuy-Dutemps performed total exenteration of the orbit, with resection of the outer wall of the orbit and removal of the lids, in a case of extensive epithelioma in a man 68 years of age. There had been no recurrence. In Paderstein's case of orbital cancer the extension of the growth had made an extensive excavation at the inner angle of the eye, and had pushed the eyeball to the outer wall of the orbit, producing a compression myopia of 5 D.

A very unusual case history of an endothelioma of the orbit of twenty-one years' observation is reported by Leenheer (*Ophthalm. Record*, p. 247, 1916). In 1904 the patient first noticed a turning of the

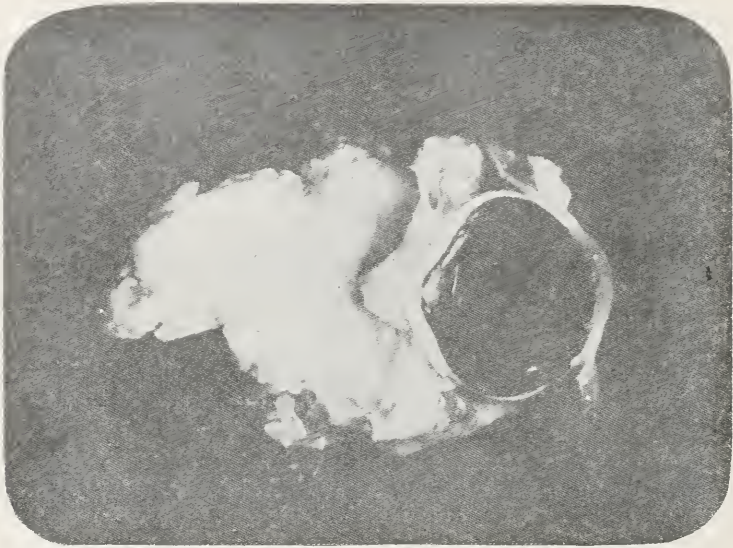


Orbital Endothelioma. Before Operation in October, 1915. (Leenheer.)

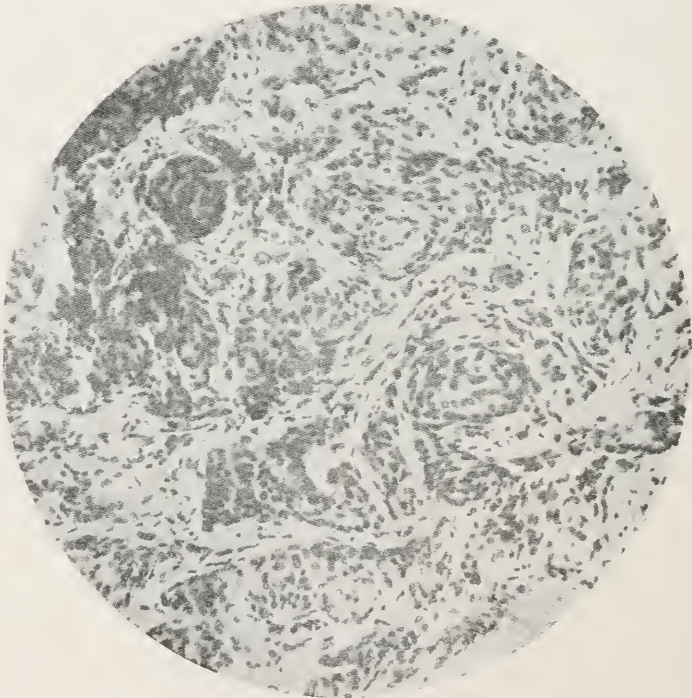
eye outwards, three years later the eye commenced to show protrusion with entire loss of vision. Eleven years later a Krönlein operation was performed. The tumor, which completely filled the muscle funnel, was removed piecemeal by blunt dissection. Ten years after that complete exenteration of the orbit was performed. The tumor mass was very adherent, especially about the foramen. The author's conclusions are that these tumors of the orbit are of slow growth, painless, and prone to recur at the site of growth and the neighboring lymph nodes not affected early. See the illustrations.

In Finzi's case of *orbital sarcoma* in a female patient aged 63 years, there was no recurrence one year following the last application of radium bromid. The first evidence of a growth presented itself four years previous to its removal. One year later recurrence took

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Orbital Endothelioma. Globe and tumor mass. October 23rd, 1915.
(Leenheer.)



200 Diameters. Hemangioendothelioma perivascular.
(Leenheer.)

place, at which time both the growth and the eye were removed and treated with radium.

In Birch-Hirschfeld and Siegfried's case a fibrosarcoma of the orbit was situated on the lower surface of a very deformed eyeball. The cornea was opaque and indented. The intraocular space was diminished, causing a folding of the choroid and retina with detachment. The growth occurred in a man, aged 43 years, and was of about eight years' duration. Following the introduction of magnesium sticks into the tumor, according to Payr, the protrusion increased. An unsuccessful attempt was made to enucleate the tumor with preservation of the eyeball. Complete exenteration of the orbit was performed.

Fischer's patient with melanosarcoma of the orbit was a woman, aged 38 years. Prominence, impaired vision and diplopia were present. Krönlein's operation revealed a tumor the size of a plum, in the posterior and outer part of the orbit, extending into the temporal fossa. The mass surrounded the optic nerve and entered the foramen. Three days after operation the patient had headache, convulsions, and was unconscious. By the eighth day the patient seemed fairly well.

Fehr (*Centralb. für Prakt. Augenheilk.*, May, 1908) describes an example of that extremely rare tumor—orbital lymphangioma cavernosum. Fehr's patient was a single woman of 45, who had always enjoyed good health. About a year and a half before she first consulted Fehr she had noticed a slight degree of protrusion of the right eye, which gradually became worse, and by and by the patient complained of some pain in the eye and in the head. She did not improve on the medicinal treatment first employed, and consulted Fehr for the first time. The condition then presented the three following important features:— (1) Exophthalmos to the extent of 12 mm., as measured by means of the ophthalmometer. Reading off the change in position required for the ophthalmometer, as the normal and the protruded eye are successively examined, enables one to estimate the amount of exophthalmos in one eye as compared with that of the other. In this instance the globe was protruded straight forward, and movements were retained unimpaired. (2) There was a considerable degree of hypermetropia, as compared with that present in the other eye. Vision of 5/15 was present in the right eye on correction of 5 D. of hypermetropia; in the left eye, which was emmetropic, vision was 5/5. The field of vision was normal and diplopia could not be elicited. (3) There was, in the right eye only, a well-marked example of choked disc.

There could, therefore, be little doubt of the existence of an orbital tumor pushing forward the globe and flattening it posteriorly in such

a way as to produce axial hypermetropia, at the same time compressing the main vessels; but of what nature the tumor might be it was not possible to be sure. A cyst was excluded, so far, by the absence of fluctuation; an angioma by the absence of pulsation, of involvement of the vessels of the lids and conjunctiva, and of increased exophthalmos on stooping; a periosteal sarcoma by the freedom of movement and the absence of diplopia. The facts that the protrusion was straight forward and that no muscles were paralyzed spoke strongly for a growth within the cone of muscles. Whether the neoplasm was malignant or not one could not be certain; the long duration was at best but an uncertain indication; at all events the growth was causing pain, deformity, and grave danger to sight. It was decided, therefore, to proceed at once by Krönlein's method to open up the orbit, and remove the tumor if possible. This was conducted in the usual way and the examining finger at once encountered a firm elastic tumor about the size of a plum, which quite filled the space between the posterior face of the globe and the apex of the orbit. Fortunately, the optic nerve was only pushed aside by the growth; adhesions were very slight indeed so that the mass was turned out with no damage to the nerve and with almost no hemorrhage. Healing was uninterrupted and rapid: in about 14 days the appearance of choked disc had died down, and even the paresis of the external rectus, which was due rather to stretching than to actual injury, gradually passed off.

On examination, the tumor proved to be, as stated in the title, a cavernous lymphangioma. The supporting tissue formed an open network, merging into the firm, complete capsule: elastic fibres were found only in immediate relation to the blood-vessels. Amid this multicellular structure was also a quantity of hyaline material, poor in cells, and firm in texture; there were no collections of adenoid tissue, lymph follicles, or masses of lymphocytes, such as have been observed in some other cases. The interstices in this network were lined with endothelium, and were of varying size, communicating with one another and containing—where they had any contents—coagulated lymph or even blood. Very few blood-vessels were to be found in the tumor tissue. In places here and there the tissue became more solid, and so crowded with cells as to suggest transition between lymphangioma and lymph-angio-sarcoma, and the preparations resemble closely those which in a similar case caused Hansemann to draw special attention to the narrow and uncertain demarcation between benignancy and malignancy in such cases. Lymphangioma is among the rare tumors of this neighborhood; only eight cases have been published hitherto; in some of

these the tumor was encapsuled, as in this case; in others it was not. One may not unfairly conclude that those without capsule are more malignant than the others.

The *Ophthalmic Year-Book* (1909-1913) has a number of brief reviews of papers on this subject, some of which are given here as follows.

Quackenboss reports a case of angioma of the orbit in which during infancy a few dilated blood vessels were seen in the conjunctiva of the lower lid, and temporal portion of the ocular conjunctiva. When 12 years old the lid became swollen and the eye pushed forward. At 23 the lid became swollen, and electrolysis was used with some benefit. At 29 there was renewed activity, the swelling extended to the upper lid, and the eye became so prominent as to make closing of the lids difficult. From this time there was slow increase in the swelling. But sight remained good until at 32 the cornea became ulcerated from exposure. The tumor was excised, with the eyeball, and was found to consist of a fibrous stroma, permeated with blood vessels of all sizes, most of them having extremely thick walls. It was found that the growth had penetrated the eyeball invading it along the ciliary nerves. The disk was covered by a swelling 8 mm. in diameter and 2 mm. high. Just below the disk the sclera was clearly invaded by the growth, which extended into the disk as a fairly defined nodule. The adjoining choroid was also involved.

Lodato's case of orbital angioma is of interest because under special staining elastic fibres, concentrically arranged, were demonstrated in the capsule. Cantonnet and Offret report the post-mortem findings in the case of a man dying at the age of 24, who when 5 years old, was operated upon by Panas for a very extensive cavernous angioma of the orbit. There was atrophy of the optic nerve extending into the chiasm, which was also carefully studied. De Lapersonne reports an angio-fibroma of the orbit removed from a man aged 23, who had noticed its gradual increase for 6 or 7 years. In Meissner's case, a hydrocephalic child 9 months old showed numerous angiomas, including some affecting the upper lid. Rollet reports 2 cases of cavernous angioma, removed without disturbing useful vision by his operation of orbitotomy. Moreau also reports a case of angioma of the orbit. Apthomas by slitting the outer canthus and dividing the external rectus, removed a cavernous angioma, in contact with the sheath of the optic nerve and extending to the apex of the orbit. Vision that had been greatly reduced subsequently rose to 6/12.

Walter R. Parker (*Journ. Mich. Stat. Med. Soc.*, 1914) reports a case of dermoid cyst of the orbit removed by the Krönlein method.

The patient, Mrs. S., aged 30, came to the clinic January 21, 1914, complaining of prominence of the left eye. The family and personal history were negative. The left eye was noticed to be larger than the right about twenty years before, but there was not much change until six years before, when the exophthalmos rapidly became more marked till in a few months it assumed the present condition. About five years before there was some pain in the eye and a progressive failure of vision began.

Vision right eye, 5/4, left eye faint light perception. The pupillary reflexes were present. Tension, right eye, 20 millimeters Hg., left eye, 4 millimeters Hg. The right eye showed no external pathology. The left eye showed marked proptosis, measurement with the exophthalmometer reading, right eye 12, left eye 35. The anterior pole of the cornea was one-half inch below the level of a corresponding point of the right eye, and was nearly on the level with the bridge of the nose. The eyeball while not enlarged was nearly all anterior to the boundaries of the orbit which was filled with a somewhat slightly movable mass. Indefinite pulsation was detected above and there was indistinct fluctuation temporarily. The insertion of the external rectus was fairly well marked and its action could be plainly seen. The movements of the eye were limited in all directions, especially in abduction.

The lids were enlarged but freely movable. The upper lid at rest completely covered the cornea leaving an elongated aperture of about one quarter inch between the upper and lower lid borders.

The palpebral and ocular conjunctivæ were only slightly congested. The fornix was occupied by loose vascular tissue showing distinct venous engorgement, and above were large venous plexuses. The cornea, iris and anterior chamber were practically normal.

The right eye showed a few vitreous opacities but was otherwise normal. The left eye exhibited a distinct secondary optic atrophy, with a pale avascular nerve head. The retinal vessels showed some tortuosity. There was quite a large area with choroidal changes situated above the disc and a peculiar striated arrangement of pigment extending down and around the macula.

Blood and urinary examinations were negative.

The X-ray report showed the maxillary and frontal sinuses open, unusually large size. On the left side, the orbit was filled with a relatively dense mass, causing a distinct depression of the lower floor and apparent elevation of the roof; sphenoid cell not involved. Some opacity was seen in the neighborhood of the ethmoids; sella turcica normal.

Wassermann test reported positive by one test, negative by another.

Very large middle turbinate on left side. There were no signs of tumor in the nose.

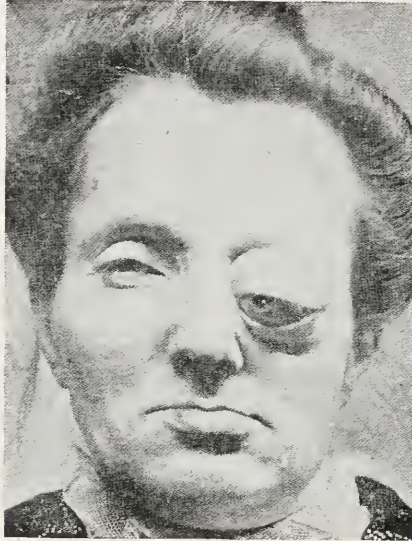
The slow growth of the tumor, absence of fluctuation, compressibility, and pulsation, together with the normal sinuses as shown by the otolaryngologic and X-ray reports lead to the diagnosis of benign tumor situated entirely within the orbit—the exact nature of which not determined. (See fig.) In the operation a wide skin incision about three inches long, semicircular in shape, convexity forward, was made temporally. A Krönlein resection of the outer wall of the orbit was done, a portion of the malar bone removed. The periosteum was dissected free from the outer orbital wall at its margin. The tumor mass was accidentally ruptured, with the escape of a large amount of brown serous fluid causing a marked recession of the eyeball. By blunt dissection the whole of the cyst sac was easily freed from the periorbital and the muscle cone, except near the apex where it was more firmly adherent to the periosteum. The deeper contents of the sac consisted of a brownish liquid, and thin pultaceous material containing fragments of hair. There was practically no orbital fat, and after the cyst was removed an unobstructed view could be had to the apex of the orbit. The wound was closed with silkworm and horsehair sutures without drainage. The eyelids were united by a single suture.

The postoperative recovery was uneventful except for some edema of the lids and conjunctiva which was controlled by pressure bandage. The ptosis was reduced from the first. When the stitches were removed about one-half dram of straw-colored fluid escaped from the incision near the outer canthus but no infection nor reaccumulation of fluid resulted.

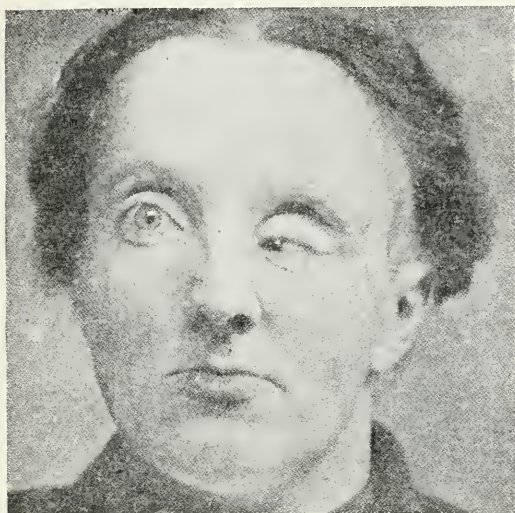
The last examination shows ptosis from lack of cushion and eyeball markedly convergent and displaced down about 11 millimeters. The eyeball can be successfully rotated beyond the median line. It is normal in appearance. (See fig.) Microscopic examination showed an old dermoid into which there had been a hemorrhage. Destruction of the epidermis, with but a few dead hairs remaining in the wall. Much cholesterol.

Mizuo (1909) reports a case of teratoma of the orbit, which grew to a length of 7 cm., breaking through the lower lid, by the time the infant was 40 days old. It contained all the elements of a fetus. Evet-sky discusses the significance of certain teratomas, concluding that they are allied to cephalomas of the orbit. Roy reports a case of calcifying fibroma of the orbit, which began with pain about the left eye and impairment of vision. Later there was swelling of the orbital tissues,

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Dermoid Cyst of the Orbit before Operation. (Parker.)



Dermoid Cyst of the Orbit after Operation. (Parker.)

and a tumor was found at the apex of the orbit and removed. After this operation there was neuromparalytic keratitis, and insensibility, such that the eye was enucleated without either a local or general anesthetic. Two years later the tumor had developed, filling the orbit and still slowly increasing. On removal it was found to be a fibroma with numerous small areas of calcification. Subsequently the orbit was closed.

Koster reports a case of supposed tumor involving the margin of the orbit in a girl of 16, and extending so deeply that complete removal seemed impracticable. The growth was supposed to be a sarcoma, but the patient was placed on potassium iodide and in 6 months the tumor had almost disappeared, and in four years she was quite well. Fernandez reports the cure of a supposed tumor of the orbit by use of sodium cinnamate. Meller reports bilateral lymphomatous growths in connection with pseudo-leukemia, and considers the orbital developments, which became as large as a man's fist, had the character of lympho-sarcoma.

Sarcoma of the orbit. This subject has been discussed already on pp. 9186 and 9187, Vol. XII of this *Encyclopedia*. Additional observations on its pathology and treatment are made here. The small-cell sarcoma of the orbit studied by Perrod (1912) had begun in the periosteum of the upper inner wall of the orbit, and from there had diffused itself throughout the orbital periosteum, afterwards extending across the glabella to the inner margin of the other orbit. Bogatsch described a case of lymphangiomatous endothelioma, which showed abundant hyalin degeneration.

Youdine saw a case of primary sarcoma of the superior rectus muscle. The growth had invaded the whole of the muscle, but the surrounding tissues were quite free from involvement. Diplopia was the first symptom. Maxson reports a case of orbital sarcoma in a new-born child. The eyeball protruded completely beyond the lids. On the surface of the child's body were sixty small tumors. Death occurred after three weeks. A second orbital endothelioma occurred eleven years after removal of the first from a patient seen by Thompson. Both tumors were encapsulated.

The small round-cell myosarcoma reported by Posey had probably been present from birth. The patient was 15 years old at the time of operation. The lumen of one of the vortex veins was completely filled with sarcomatous spindle cells. Platt records a case of sarcoma of the suprarenal body, with secondary involvement of the vault of the skull and of the orbits. Santos Fernandez held a recurrent orbital



Dermoid Cyst of the Orbit. (Stieren.)



Dermoid Cyst of the Orbit after
Operation. (Stieren.)

sarcoma in check for a year by injecting into the mass a solution of cinamate of soda.

Although chloroma (see **Chloroma**, p. 2066, Vol. III of this *Encyclopaedia*) is thought by a number of writers to be essentially a disease of the hematopoietic system, yet as regards the eye at least its clinical manifestations are those of a neoplasm. Thus in the orbital chloroma studied by Hudson there was great proptosis and marked impairment of movement of both eyes, together with the consequent corneal injuries. At autopsy both orbital plates of the frontal bone were found infiltrated with green material, and between the roof of each orbit and the levator palpebrae was a brawny mass one-half inch thick. The pathologic changes in the various body tissues were essentially the same, consisting of a diffuse infiltration with a peculiar type of granular cell (myelocyte), such as is normally almost confined to the bone marrow. The diagnosis was not made until after death, the possibility of a thrombosis of the cavernous sinus, and of sarcoma formation with metastasis, being successively considered in explanation of the general symptom complex.

In Sattler's case, prominence and symmetric induration of the lachrymal and parotid glands gave to the face and eyes, for a short time, the typical expression of Mikulicz' disease. This was the result of a steady growth of subperiosteal swellings in the apex and lateral walls of the orbit and face. In spite of the common agreement which exists as to the constitutional character of chloroma, a patient who was under the care of Hynek and Kadlicky showed striking general improvement four months after removal of the orbital masses, which failed to recur. Nevertheless, the presence in the blood of increasing numbers of myelocytes revealed the persistence and general distribution of the pathologic process.

McConnell and Burman report a case of melano-sarcoma of the orbit in a man of 64, which required 8 years to run a fatal course. After enucleation it remained quiescent for several years. After a second operation the tumor rapidly increased and the patient soon died of metastases of the liver. Muetze's case followed a blow on the nose, and was first reported as a tumor of unknown character. After a second operation it was found to be round-celled sarcoma. Again it recurred and the orbit was eviscerated. Hirsch reports a case of chondro-sarcoma. The tumor followed an operation for dacryocystitis and extended into the antrum and ethmoidal cells. The patient died a year after the first operation, having also undergone a resection of the jaw.

Weeks reports a case of myxosarcoma of the orbit seen 9 weeks

after a fall on the back of the head. There were signs of traumatic exophthalmos, but the swelling did not pulsate. An exploratory Krönlein operation had been made, showing no neoplasm. The common carotid was tied, arresting the development of the exophthalmos for ten days. But later a tumor developed with great rapidity. Henderson reports a sarcoma developing in the region of the lachrymal gland, but not involving it. It was removed and the parts appeared healthy 8 weeks later.

Frank Allport (*Oph. Record*, July, 1912) reports the removal of a spindle-celled sarcoma from the right orbit followed by recovery with intact ocular apparatus. The author remarks that as one is generally obliged to deal with intra-orbital tumors whose recurrence is highly probable, it is a satisfaction to be able to report, now and then, the extirpation of a sarcoma whose form renders the result more favorable.

Miss A. B. C., age 24, consulted the writer October 26, 1911. She had had perfect health. December, 1910, she noticed a slight prominence of the right eye, which very slowly increased, although even now it is barely noticeable. Vision = 20/20. Fundus normal. No diplopia. Maddox = 1 deg. exophoria. Abduction = 7 deg.; adduction = 18 deg. There is a slight divergence of this eye on fixation. There is a little fulness of the lid in the upper inner angle and the presence of some abnormal growth can be faintly detected on deep palpation; it has not the feeling of bone and there is no pain. An examination of the nasal spaces by Brawley revealed nothing abnormal. The field of vision is normal.

A curved incision, similar to a Killian frontal sinus incision, was made. The opening was cautiously deepened, care being taken to avoid injuring either the superior rectus, internal rectus or the superior oblique muscles. An opening was made through the orbitotarsal fascia and a roundish body was clearly seen between the lips of the incision. A large spoon curette was gently inserted beneath the growth, by means of which the tumor was completely enucleated, without rupture of its capsule.

The attachment to the orbital walls was slight and pediculated. The tumor was about the size and shape of a small pecan-nut. A second tumor of practically the same description was now likewise enucleated, and then a third of about the size of a small coffee bean. They were all encapsulated; the capsule in each was removed unbroken. Artery forceps were not used, as the bleeding was not profuse, and was reasonably well controlled by adrenalin. The sides of the wound were held apart by long, smooth hand-retractors. One of the retractors also held the eye away from the field of operation. A careful examina-

tion with the finger seemed to show that all abnormal tissue had been removed. Irrigation and suturing followed. Recovery was uneventful. The patient was dismissed in six days, at which time her vision was 20/15 and her fundus was normal. The proptosis and divergence disappeared and the muscular action was normal. Abduction 5 degrees. Adduction 18 degrees. Maddox 1 degree exophoria.

The pathologic report of the largest tumor shows that "It is surrounded by a definite, firm, fibrous capsule. The interior is soft, friable, and grayish in color, some parts being firmer than others. There are no hemorrhages or necroses. The tissue is composed of spindle-cells which are arranged in bundles and whorls with a moderate amount of intercellular substance. Dividing nuclei are seen but are not numerous. The tissue is not highly vascular. The tumor belongs to the sarcoma group and is of the spindle-cell variety. From the relatively few mitotic figures present and because of the presence of a well-defined capsule the tumor does not appear to be highly malignant."

On June 2, 1912, the patient was to all appearance in good health; ocular condition as before reported.

A fibrosarcoma of the orbit is reported by Robert S. Lamb (*Wash. Med. Annals*, No. 4, 1915). The patient, a female, colored, aged 39, housewife, had been visiting the clinic at Freedmen's Hospital for some time for pain and exophthalmos of the left eye. Eighteen months before, the patient had noticed pain and beginning swelling. The pain had been controlled for a while, but eventually it became so severe and sight so useless (she saw only large objects and had poor projection) that it was decided to remove the eye which was causing the pain and possibly remove the tumor which lay behind the eyeball, and in the writer's estimation was plainly the cause of the secondary glaucoma; therefore the patient was admitted to the hospital Sept. 11, 1913. Operation: Behind the eyeball was found a mass filling the posterior half of the orbit, including the apex, and apparently attached to the periosteum. To digital examination it felt as does the cervix uteri or the tip of the nose, slightly depressed at the center. In view of the fact that there had been an innominate aneurism, with mitral insufficiency, and there had been objection on the part of the anesthetist to giving the anesthetic in such a case, and the possibility of an exenteration taking considerable time, the operator decided to abandon the operation at this point. The writer believed that perhaps the bone was involved; that it was probably a hopeless condition, and that any operation would, of necessity, be so extensive that it would

hardly be advisable; besides which consent would have to be obtained from the woman and her husband before proceeding any further.

The patient got on very well following the operation, but the tumor began to grow and finally extruded from the orbit and became painful; it was then decided, at the end of several months, during which the X-ray had been in use, and as the tumor had softened somewhat, yet had increased in size, it was to the best interest of the patient to do a complete exenteration of the orbit. She was, therefore, readmitted to the hospital and the second operation was done Jan. 25, 1914.

An exenteration was effected, almost complete, that is, complete except for the very tip of the apex of the orbit in the neighborhood of the optic foramen; this portion was cauterized deeply, practically to the foramen, at three or four places, thereby shriveling the bleeding mass. The wound behind it healed very well, except for a slight supuration which ceased as soon as the X-ray treatment was resumed. The patient has been quite well since then and the other eye has never been affected. Of course the length of time is not great, but a year and a half of comfort and health, free from worry and anxiety, has been a great benefit to the patient. The pathologic laboratory report was fibrosarcoma. There is no sign of recurrence.

Treatment of *blood cysts of the orbit*. Three cases of this condition are reported by Harold Gifford (*Amer. Jour. of Ophthalm.*, 1918, p. 178).

Case 1. A boy aged 8 years, was taken to the writer in June, 1905. There was a history of his having fallen and struck the left eyebrow when two years old. The father thought that the left eye was a little larger than the right, but it gave the child no trouble until two days before consulting Gifford, when it began to cause pain and to protrude.

The right eye was found to be normal, and the left was pushed far forward and downward, the cornea being about 5 mm. farther forward than that of the right eye. The ophthalmoscope showed somewhat enlarged veins, but no other abnormality. The vision was 20/20—. The boy felt ill and had considerable pain at times. He was put to bed and given full doses of potassium iodide with some apparent improvement. But after three weeks, as the exophthalmos was evidently increasing, the contents of the orbit were exposed by the Krönlein method, and a dark-colored tumor within the muscle funnel could be seen extending back toward the apex of the orbit. The tumor was nearly three-fourths of an inch in diameter and felt quite firm. On attempting to outline it with the finger, it suddenly collapsed and a large quantity of dark-brownish fluid poured out of the wound. On cleaning this away one could neither see nor feel the tumor. So the

outer wall of the orbit was replaced and the wound healed without any reaction.

The pain ceased at once and the eyeball returned to a nearly normal position. Three months later the boy was brought back with the eyeball bulging nearly as bad as ever and the sight of the left side reduced to about 20/100. The outer wall of the orbit was again turned back, and when the periosteum was raised the tumor was plainly visible. This time before palpating it, Gifford secured the tumor by passing a suture through its wall. It was again opened and a brownish fluid similar to that seen at the previous operation was evacuated.

The cyst was multilocular, since, on introducing the finger into the first cavity, one or two other cavities were broken into and evacuated. The cavity led along the optic nerve to the apex of the orbit. It was swabbed out, first with dry swabs, then with swabs dipped in 95 per cent. phenol, the latter being passed firmly down to the end of the cavity, and finally with swabs dipped in alcohol. The bone was then replaced, and although the patient had a temperature of 102° F. at the end of twenty-four hours, on the succeeding day it became normal, and there was no further reaction.

The eyeball receded so as to be very little, if at all, more prominent than the right eyeball. There was a slight convergent strabismus, and the vision at the end of two weeks, without the correction, was 20/30—. When the patient was last heard from, about two years later, the condition was satisfactory.

Case 2. R. G., a strong, healthy boy, aged 15, was taken to Gifford April 3, 1917. There was no history of any injury. In January, 1916, the mother noticed that the left eye seemed a little larger than the right. This difference slowly but steadily increased; until, at the time of the first examination, the left eye was pushed forward about one-half inch farther than the right, with a somewhat limited motion inward.

The vision was 18/20+, and the fundus normal. There was no diplopia and no pain. The right eye was normal, the vision being 18/15. As an examination of the nose and a roentgenogram gave no clue to the cause of the exophthalmos, an exploratory incision through the outer half of the eyebrow was made and a firm but somewhat elastic tumor could be felt filling up the outer half of the orbit, extending to an undefined extent backward and inward.

In spite of his experience of the preceding case, the writer gave a very guarded prognosis as to the possibility of being able to remove the tumor without spoiling the eye. One week later he cut away enough of the outer wall of the orbit to expose the tumor plainly, and

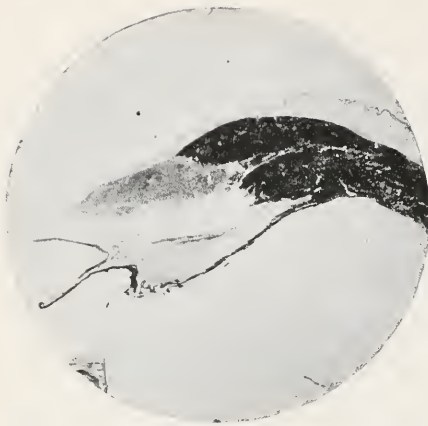
while passing a suture through the tumor to aid in removing it, a little dark-brown fluid escaped, which led him to incise the tumor freely. It turned out to be a large cyst, made up of several pockets more or less completely separated and filled with a brownish fluid. These were broken up with the finger, and after firmly packing the cavity, which extended back to the apex of the orbit, phenol was used freely as in the preceding case, and finished by swabbing with alcohol.

A small drainage tube was left in the external wound for two or three days, but there was no reaction nor discharge. When the boy went home several weeks later, the vision was normal in each eye. The left eyeball was very slightly more prominent than the right, with movement inward and outward slightly restricted. There was a slight ptosis and diplopia on the patient's looking to the left. Five months later the patient's surgeon wrote Gifford that the eye had receded to its normal position.

Case 3. Mrs. W. P., aged 40, came in October, 1909, complaining that for three years she had been having pain in the right eyeball, which had been gradually getting larger than the left. The right eye protruded at least a half inch farther forward than the left, and there was moderate restriction of motility in all directions, especially to the right. The fundus was normal and the vision 20/20—, with correction. The left eye was normal and the vision with correction was 20/20+. As no operation was desired, the patient was not seen again for five months, when she returned with the exophthalmos and restriction of the motility in the right eye more pronounced. The vision and fundus were unchanged.

The outer border of the orbit was then removed and a somewhat pyramidal tumor $1\frac{1}{4}$ inches broad at the base and $1\frac{1}{2}$ inches long was removed from behind the globe by a blunt dissection, except at the last stage, when a rather firm band had to be cut with the scissors. The exterior of the tumor was very irregular, showing a number of dark nodules, and being cut open before hardening, it proved to consist of a mass of connective tissue filled with spherical pockets from $\frac{1}{8}$ to $\frac{3}{16}$ inch in diameter, each pocket being filled with a mass of coagulated blood. These masses shelled out of the pockets like peas. Toward the center of the tumor the blood clots seemed fresher than toward the periphery.

The operation was followed by no reaction and the patient went home in two weeks with the vision in the two eyes the same as before the onset of the trouble. The exophthalmos had disappeared, but motion was still somewhat restricted in all directions. The lower half of the pupil showed a moderate dilatation and did not respond to light



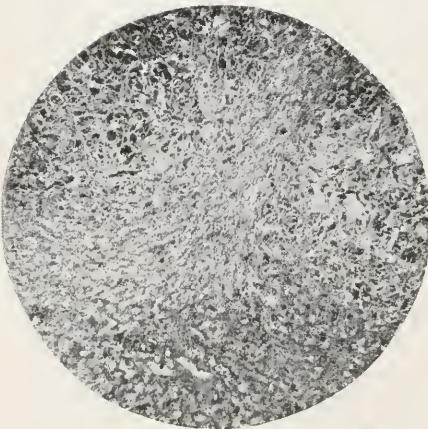
Note Position of Tumor, and Lack of
Pigment in Anterior Third.



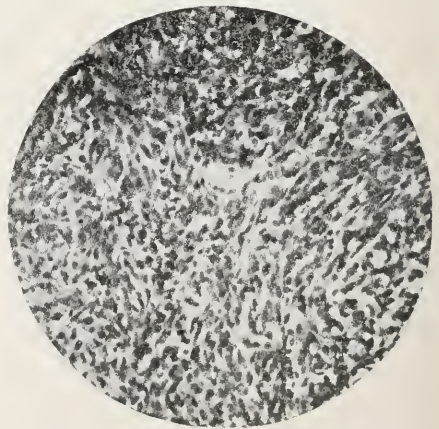
Anterior Surface of Iris, Posterior Sur-
face of Cornea and Angle of Anterior
Chamber Covered with Tumor Cells.



Ectropion of Pigment Layer of Iris.



Area from Unpigmented Epibulbar Por-
tion of Tumor.



Section from Metastatic Nodule in
Liver.

Melanoblastoma of the Eye. (Forman and Hugger—*Am. Jour. Ophth.*, Feb., 1918.)

or convergence. The fundus was unchanged. There has been no sign of a return.

The interest of the last case centers in the unusual nature of the tumor. Without pretending to say that others of the same nature have not been reported, Gifford has not been able to find any. Apparently the tumor was the result of an intermittent leak in some small vessel, the hemorrhages occurring from time to time and becoming encapsulated so that they were separated by well-defined walls.

The contents of the cysts in Cases 1 and 2 were not examined microscopically nor chemically, but as they presented the characteristic appearance of disorganized blood, they probably resulted from defective blood-vessels which leaked more continuously than in Case 3.

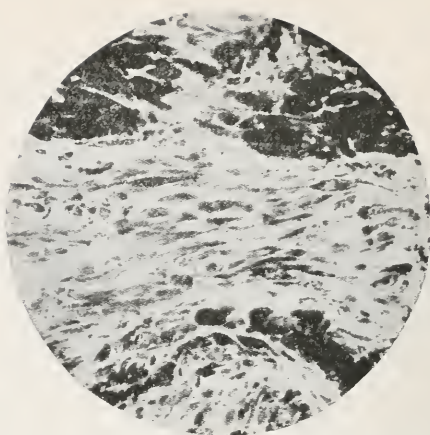
Although Case 3 naturally suggested a much more serious prognosis, it would have made no difference in the treatment, even if the nature of the tumor had been known. In Cases 1 and 2, on the contrary, the writer thinks that not only was the prognosis faulty, but if the capsules of these cysts had been a little thicker, Gifford would undoubtedly have persisted in his attempt to enucleate them intact and might have done so at the risk of causing the loss of the eyesight or of the eye in either case.

As to the proper treatment of these and other deep-seated orbital cysts, except rare forms like that in Case 3, if such results as were produced in the first two cases can be generally obtained, it is evident that it would be a mistake to attempt to enucleate them; or to cure them by curetting, until the simpler treatment with phenol or something similar has been tried. Whether the injection of tincture of iodine, which some authors suggest (apparently without having tried it themselves), would be as effective and safe may well be doubted. In case of recurrence after using phenol, Gifford suggests trichloroacetic acid, and says that if in the future he should encounter a dermoid having the long, sinus-like extension occasionally seen he would destroy the skin lining it with trichloroacetic acid rather than try to excise it or to destroy it with silver nitrate or iodine, as recommended by Buller, according to de Schweinitz.

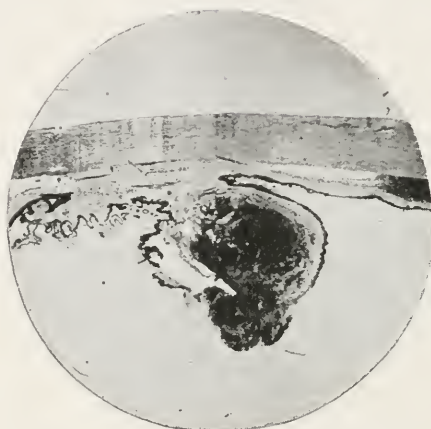
The writer concludes that in every case of deep-seated orbital tumor of uncertain nature, the possibility of its being a blood cyst or some other benign cyst should be considered. If an operation is done, the tumor, on being exposed, should be secured by passing a thread through it and its nature should be tested by a puncture. If it proves to be a cyst, thorough cauterization with phenol, or something similar in effect, should be tried before an attempt is made to extirpate it.



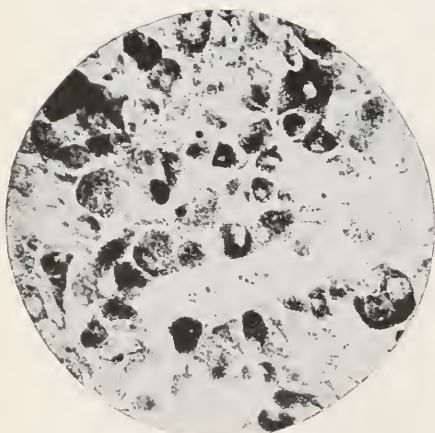
Iris Bound to Ciliary Body by Granulation Tissue.



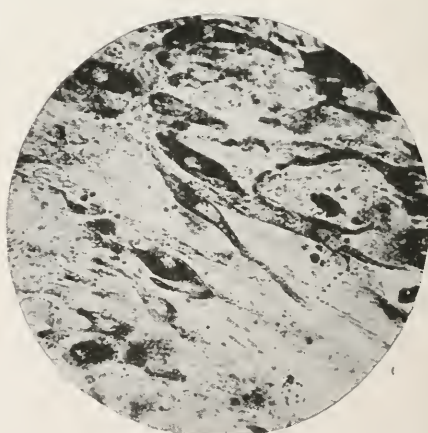
Tumor in Optic Nerve. Infiltrating Spindle Cells Containing Pigment, Supported by Tissue of the Part.



Tumor in Posterior Part of Ciliary Body.



Variations in Size and Shape of Cells.



Tumor Cells with Net-Work of Tissue Cells Interspersed.

Melanoblastoma of the Eye. (Forman and Hugger—*Am. Jour. Ophth.*, Feb., 1918.)

Zentmayer (*Am. Journ. Ophthalm.*, 1918) presented a case of microphthalmos with orbital cyst in a boy aged 17 years, who was born with the present condition of his left eye, except that the swelling about the eye had increased since the twelfth year. There was a swelling of the lower lid, with ectropion and obliteration of the culdesac. A globular tumor could be felt through the lid, which seemed to be attached toward the temporal side and was but slightly movable. In the upper inner portion of the orbit there was a small rudimentary globe having limited movements. The cornea was 4 mm. in diameter. The X-ray did not show the cyst. In the right eye there was a partial coloboma of the optic nerve.

Burns described a case of dermoid cyst in the orbit of a girl, aged 8 years, following an injury to the head, six years before. The eye was displaced forward and outward, and there was diplopia. Vision was almost normal. The X-ray examination showed a tumor involving an area in the orbit, temporal fossa, and cranial fossa on the right side of the skull. The tumor was removed and recovery was uneventful.

Koyanagi's case of blood cyst in the orbit and lids, occurred in a woman, aged 25 years. There was a swelling of the upper left lid, which communicated with the orbit and which proved on extirpation to be a large blood-cyst, containing two roundish thrombi which had undergone chalky degeneration. The outer wall of the cyst was composed of connective tissue and the inner wall of the epithelium.

Osteoma of the orbit. See, also, p. 9184 and p. 9198, Vol. XII of this *Encyclopaedia*. Consult, in this connection, **Orbit, Operations on the**, p. 9147, Vol. XII.

An instructive essay on the *diagnosis and treatment of orbital osteomata* is offered by Charles Wray (*Med. Press*, May 5, 1915). He gives Herschfeld's figures showing that the mortality in cases of sinus growths—frontal, ethmoidal and sphenoidal—is 48.2, 80, and 100 per cent., respectively; while the post-operative mortality is 13.6, 12.7, and 33 per cent. The two main methods of diagnosis are by palpation and the use of Roentgen rays. An examination by fingers is too limited; he advises the use of a thin, flexible spatula 10 mm. wide and 2 mm. thick at the ends; this presses on the skin under the supra-orbital notch, passes 15 mm. under the lid, and via the fornix 33 mm.—i. e., within 12 or 13 mm. of the sphenoidal fissure. The measurements at the lower orbital margin are 12 and 16 mm. respectively; while at the inner and outer canthus the distance reached is 15 and 21, and 11 and 22 mm.; and as the usual distance from the margin of the orbit to the rectal spine is 45 mm., it is possible thus to investigate half the

outer wall of the orbit. In the living subject it is desirable to administer morphin an hour, and deep injections of novocain ten minutes before beginning the examination.

With regard to operation, he laid stress on the importance of dissecting up the superjacent membrane if present, and the periosteum, so as to shut off, as efficiently as possible, the field of operation from the contents of the orbit. Having tested the hardness of the growth, an attempt should be made to test the strength of the attachment to the bone, as slight leverage might snap the pedicle. If this does not occur and the tumor is cancellous it should be removed piecemeal, so as to discover its relation to the orbital wall. If originating from a subjacent sinus, and especially if hour-glass shape, the bone should be cut away so as to allow of easy removal in the safest direction. Two important landmarks are the inner canthus (over the anterior extremity of the middle turbinated) and the anterior ethmoidal foramen (giving the level of the cribriform plate). Frontal sinus cases are the most frequent, and usually present at the upper and inner part of the orbit. No operation should be undertaken in the presence of material alteration of the roof of the orbit as revealed by X-rays. Ivory exostoses cannot be removed piecemeal. As in the cancellous variety, gentle leverage is in order, and in the event of failure, sufficient of the orbital wall should be cut away to permit of removal in the safest direction. A clue to the size and location of the growth is obtained by radiography and the use of a strong needle.

Blanco (*Arch. de Oftalm. Hispano-Amer.*) describes a case of osteoma of the orbit. A girl 19 years old noticed a swelling on the upper part of her left eye and came into consultation. There were no available data, and the patient did not remember having had any traumatisms. Examination showed a tumor that merged into the orbital border, and free from the skin and fasciæ. On the affected side the eye could not be opened so much as on the other side, and there was diplopia only on looking towards the left. On this movement the eye could not follow its fellow and became deviated to the outside and downwards. The deviation was similar to that caused by the paralysis of the inferior oblique of the left eye. A diagnosis of osseous tumor of the orbit was made. The patient was operated and the tumor resected very easily. The eye was not affected by the tumor and the patient recovered very shortly afterwards. The pathological examination of the tumor confirmed the diagnosis. The frontal sinuses were entirely free from any ramification of the tumor.

M. Greco (*Archivio di Ottal.*, 21st year, p. 606) reports an instance of combined orbital osteoma and angioma of the eyelid.

According to the patient, a man of 45 years, the condition had been present since he was 6 years old, having appeared after attacks of vomiting. The region of the right lower lid and lachrymal sac presented a swelling of the size of half a mandarin orange, more prominent at the nasal end. Its upper border was distant 0.5 cm. from the free margin of the lid. The mass was composed of two distinct parts. The rounded nasal portion was bone hard, and of the size of a filbert. The outer portion, two-thirds of the whole mass, was completely independent of, but closely applied to the outer aspect of the bony growth, and had a soft but not fluctuating consistency. Beneath the soft mass the lower orbital margin was perfectly regular throughout. On account of a discoloration of the skin and of the presence of venous arborization along the skin of the lower lid, the author diagnosed the simultaneous presence of an angio-lipoma and an osteoma.

A case of ivory osteoma of the orbit is reported by E. Cramer (*Klin. Mon. f. Aug.*, 53, p. 147). A man noticed, fifteen years before, a swelling at the right eye with which, until a short time before he could see well. Three weeks ago he had erysipelas at the region of the tumor. The swelling commenced with a round, stone-hard formation at the back of the nose; the upper orbital margin was very much thickened. The eyeball protruded 1.5 cm. downwards and outwards; pupillary reaction defective; optic disc snow-white; retinal vessels narrow. V. = 0. The posterior portion of the middle nasal meatus was obstructed by a hard, white mass. Through an incision from the eyebrow over the back of the nose to the medial canthus a large bony tumor without periosteum was laid bare. On further dissection downwards a large quantity of black, watery, lightly mucous liquid was evacuated. By a few strokes of the chisel the tumor was detached from the nasal process of the supramaxillary and frontal bones. It measured 3.5x2.2x2. cm., and was as hard as ivory. Its lower and medial surfaces were irregular and filled with black detritus and a small sequestrum. After cleansing the large wound cavity another yellowish-white tumor, of the size of a hazelnut, became visible in the ethmoidal region of the middle meatus. This was also extirpated. After a few days another such tumor, 1.9x1.20 cm., located at the medial portion of the supraorbital margin, was removed after detaching the periosteum. Cramer assumes that the tumor with the described contents originated in a thin-walled cyst of the ethmoidal region which was by an unknown irritation converted into a bony shell, grew and produced, by pressure on the neighboring orbital walls, a periostitis with subsequent formation of exostosis.

S. Cirincione (*Annali di Ottalm., e Clinica Oculistica*. First year,

page 81; abst. *Am. Journ. Ophthalm.*) describes several cases of orbital osteoma.

The first patient was a man of 25 years who had noticed for five years that the left eye gradually became more prominent than the other, and in the same period that the vision of the left eye had gradually diminished. The left eye protruded 1 centimeter and was pushed 5 millimeters down and slightly outward. The vision was 1/10, not improved with lenses. The size of the tumor had apparently been stationary for three years. Operation was therefore done chiefly for cosmetic purposes. An incision was made along the upper inner orbital margin. The elevator of the upper lid was separated from the periosteum and displaced downward. The tumor consisted of two large lobes, each of the volume and shape of a medium-sized chestnut, implanted on a broad base in the upper inner wall of the orbit. The tumor was of eburnated hardness, and at some points was broken into fragments in the course of the operation. At the end of two years after the operation there persisted a very slight degree of ptosis, only visible when the eye was directed upward, and a strabismus of 10 degrees only. There was no sign of recurrence of the tumor.

The second patient was a girl of 16 years. A disturbance of vision of the left eye had been noticed for three years, and for the same length of time a small hard swelling at the upper inner angle of the orbit. The tumor had increased in size without pain. The eyeball was pushed forward 3 millimeters and turned outward 30 degrees. The vision of this eye was two-thirds of the other eye, normal. The tumor, which was of the volume of a small cherry, somewhat flattened from before backward, appeared to have taken the place of the pulley of the superior oblique muscle. After dissecting free the tendon of the muscle, the tumor was easily chiseled from its attachment to the wall of the orbit. Microscopically it was found to consist superficially of compact bone tissue, and internally of spongy bone tissue.

In the third case, that of a man of 21 years, the protrusion of the eyeball had been first noticed four years previously. The posterior pole of the eyeball was in the same plane with the orbital margin. The displacement was 2 centimeters downward and 3 centimeters outward; nevertheless, the eyeball was covered by the upper lid. At operation almost the entire orbit was found to be filled with an extremely hard bony mass which was immovable and formed an integral part of the orbital walls. The operation practically consisted in excavating a new orbital cavity in the bony mass. A radiograph showed a tumor mass not merely extending from the wall of the orbit toward the eyeball, but also upward into the brain cavity. In the orbit the bony mass

had taken the place of the superior orbital walls, and also of the orbital portion of the superior maxillary bone and partly of the large and small wings of the sphenoid bone. At the time of reporting three years had elapsed since the operation, and no change had taken place in the position of the eyeball as compared with that which it occupied in the new orbital cavity shortly after the operation.

P. B. Ferro (*Boletín de la Sociedad de Oftalmología de Buenos Aires*, January, 1915) successfully extirpated an orbital osteoma. The patient was a student of nineteen years, who came complaining of displacement of his left eye, which he had noticed for about a year. The eye was turned downward and outward, and there was an irreducible exophthalmia. There was no diplopia, no changes were found in the fundus of the eye, and the tension and vision of the eye were normal. The tumor was situated about a centimeter from the superior orbital margin, at the junction of its inner and middle thirds. It was removed under chloroform. It was about the size of a walnut, hard in consistency and firmly attached to the roof of the orbit. The patient recovered without exophthalmos or orbital deformity, or interference with the movements of the eyeball.

Psammoma of the orbit. This subject is fully treated on pp. 10416, Vol. XIV *et seq.* of this *Encyclopedia*. In this text are cuts of the case of orbital psammosarcoma described by de Schweinitz, a description of which will be found in the place just cited.

The following brief abstracts of *additional cases of orbital neoplasm* are copied from the *Oph. Year-Book* for 1916.

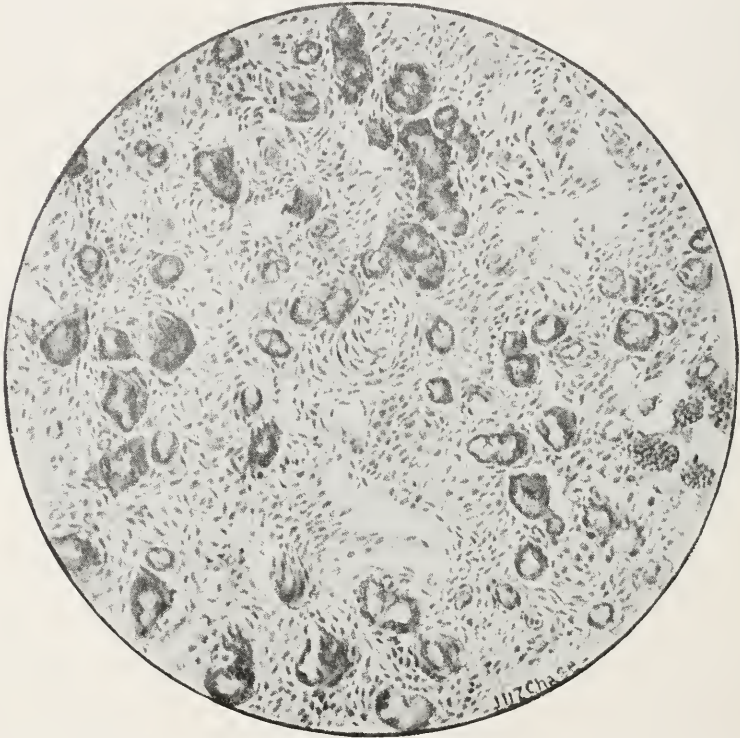
A case of dermoid at the inner point of the orbit observed by Posey showed a striking resemblance to a mucocele of the ethmoidal cells. Knapp removed from the apex of the orbit, without injury to the eyeball, a fibroma 22 mm. by 12 mm. It was apparently adherent to the optic nerve sheath. The patient was a girl, aged 17 years. The operation was after the method of Krönlein. Previously operations had been performed to remove a plexiform neuroma with multiple pigmented tumors of the lids.

Veasey's case of osteoma of the frontal, ethmoidal, and sphenoidal sinuses involving the orbit and anterior cerebral fossa had a marked downward and outward proptosis of the eyeball. The lids, however, could be entirely closed. The condition had slowly increased during a period of at least eleven years. The skiagraph showed involvement of the orbit and anterior cerebral fossa, extending from the frontal sinus to the sella turcica. Many illustrations accompanied the published report.

Hunter's patient, a woman aged 47 years, showed a slow growth,

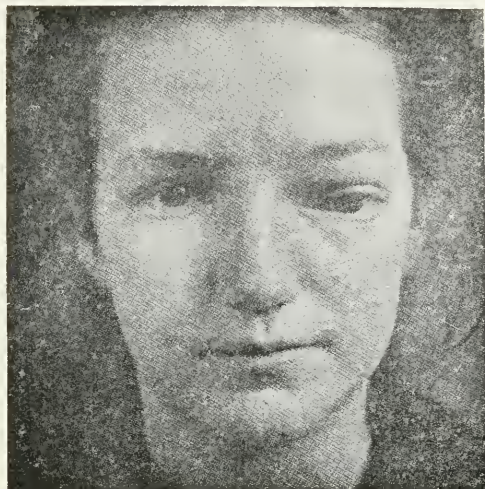
possibly of twenty months' duration, springing from the periosteum at the upper nasal quadrant of the orbit. The mass had a soft point of apparent fluctuation at its temporal edge. Diplopia was present on upward movement of the eyes. Roentgen rays of the sinuses were negative.

Halben (*Berlin. K. Wochenschr.*, Dec. 27, 1915) reports the removal of an orbital fibrosarcoma as large as an apricot. While it filled the

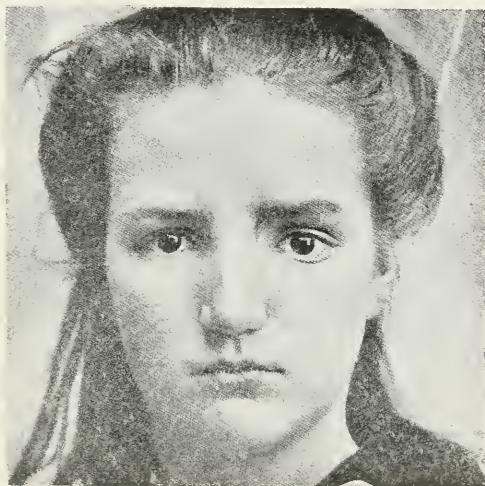


Psammosarcoma of Orbit; spindle-cells, "sand bodies" and free hemorrhage.
(de Schweinitz.)

orbit, thrusting the eye forward, it proved to be nowhere adherent, either to the bone, optic nerve, or muscles. Nevertheless compression of the orbital walls had diminished their resistance. The optic nerve was flattened against the nasal wall. Krönlein's technique was used to enter the orbit. The growth was in contact with all the orbital walls but was readily enucleated with the finger. The extraction was strikingly like delivery of the fetal head in labor and was followed by a gush of blood. There was complete amaurosis but the ophthal-



Psammosarcoma of Orbit.

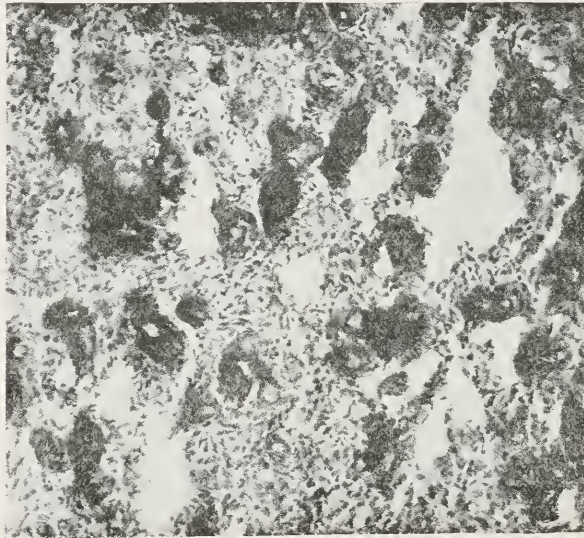


Psammosarcoma of Orbit. Result after operation.

moscope showed that the fundus was normal. In a few days the patient was able to count fingers.

H. Kirkpatrick (*Br. Journ. Ophthalm.*, p. 364, 1917) describes a double orbital sarcoma in a male Mohammedan Indian, aged 50 years.

He stated that the trouble began in the right eye a year previously, when he noticed water, and later, pus collecting at the inner angle of the eye. Two months before admission, he observed a tumor in the lower lid of that eye. Watering of the left eye began six months before admission, and the tumor was noticed in the lower lid one month



Photomicrograph of Psammosarcoma of Orbit. (de Schweinitz.)

later. This began in the lachrymal sac region and gradually spread outwards. No pain was ever present on either side. His general health had always been good, but he had suffered from excessive sneezing since the watering of the eyes began.

Both the lower lids were prominent and pouched, and a firm, well-defined tumor, which reached far back into the orbit, could be felt beneath each of them. The tumor on the left side was slightly larger than that on the right. The skin and orbicularis muscles were freely movable over the tumors. Movement of the eyeballs downwards was limited. Purulent retention was present on the right side, whilst on the left the lachrymal passages were obstructed but free from retention. No glandular enlargement was present.

The tumors were removed; the left consisted of two lobules which were semi-transparent, with bluish and pink mottlings, and were united by a firm fibrous band. It stretched far back into the orbit and was fixed to the inner wall and to the tissues behind. The right tumor was smaller and more elongated. It was lobulated but single. One very firm attachment lay over the lower end of the lachrymal sac, and it was also firmly fixed to the orbital tissues.

On microscopical examination, the tumors were found to be identical in structure. They were composed of cell groups separated by fine branching spaces giving a streaky appearance to the section. Many of the spaces contained red blood corpuscles. The cells were rounded and oval, with very little protoplasm in proportion to the nucleus. Some of the nuclei had a vesicular appearance. The tumor was probably an endothelioma of sarcomatous type.

The patient made a very good recovery, but the action of the ocular muscles was interfered with for about a month. He was last seen three months after the operation, at which time he was very comfortable and no recurrence had taken place.

From *Ophthalmic Literature* (1918) the following short reviews are culled.

Wible's patient had an orbital growth for about two years. Following exenteration, the pathologic report of the specimen was rhabdomyoma. Few cases of this rare growth have been reported in literature.

The cosmetic results were almost perfect in the patient Posey exhibited, from whom he had removed an adenoma of the orbit. Wright reports a rare growth observed in a female, aged 58 years. Six years previous, she was operated upon for a femoral hernia, which may have been an ovariectomy. During a period of some twenty months the patient suffered attacks of pain in the left eye, followed by perceptible loss of vision. The eye was enucleated for chronic glaucoma. About six months later, a secondary mass was removed from the orbit. Microscopic examination showed the presence of a malignant papillary cyst adenoma. The walls of the eyeball were involved. Tumors of this type are usually found in ovaries, breast and intestinal tract, and never as a primary growth, at least, about the orbits.

Coover presented a patient, aged 11 years, from whom he had removed a fibroma of the orbit. The mass, 25x35 mm., was adherent to the foramen and optic nerve on the temporal side. In its removal the optic nerve was injured, necessitating enucleation of the globe.

Griffith exhibited a patient, a female, aged 33 years, with proptosis of the left eye, movements free in all directions. A distinct new-

growth was palpable, at the back of the eye. There was no light perception or pupil reaction; nevertheless, the optic disc was of good color and the vessels were full. Calderaro did an excision of a tumor of the orbit, without appreciable cicatrix and without enucleation of the globe.

Cirincione contributes the history and operative procedure in three cases of endorbital osteoma. In the first two patients, the mass occupied the upper inner part of the orbit. One occurred in a man aged 25 years; the other in a girl, aged 16 years. The third patient was a man 21 years old, in which the mass occupied the whole orbit, pushing the eyeball forward so that the posterior pole was on a plane with the margin of the orbit. The operation consisted of practically excavating a new orbital cavity. The growths were from three to five years' duration.

In Blanco's case of osseous tumor of the upper part of the orbit, the eye deviated down and out. Removal of the mass was accomplished without any damage to the eye. Posey exhibited a patient, a male, aged 19 years, with an orbital growth, possibly an osteoma. The mass was hard and bosselated, confluent with the supraorbital rim and merged with the inner wall of the orbit. The growth was first observed eight or nine years previous. Vision equalled 5/10. The mass was to be extirpated through a large incision under the brow.

Hupp's case of exostosis of the orbit occurred in a man aged 26 years, who gave a negative family and personal history. Fifteen years before, without apparent cause, there was noticed a small hard lump within the right orbit, on the nasal side. While for years this bony growth remained quiescent, a few months before examination, blurring of vision, diplopia and pain became manifest. A hard, rounded, bony tumor, the size of an English walnut, protruded from the nasal side well beyond the orbital margin. The tumor was removed and proved to be attached to the orbital plate of the ethmoid.

Kalt's case of multiple exostosis occurred in a boy aged 13 years. His personal history was negative, but the mother gave a history of exostosis of the ramus of the lower jaw. One of the bony growths was situated at the inner orbital margin on the left side, pushing the globe backward and upward. The tumor, the size of a walnut, was removed. Its attachment was near the junction of the os planum of the ethmoid and the lachrymal bone. Similar exostoses were present on the left external nasal wall, the anterior lachrymal crest, and the ascending apophysis of the superior maxillary bone.

An interesting experience is reported by Chance in the removal of a cavernous angioma of the orbit. The patient was a female, aged

16 years, with a tumor first noticed soon after birth, which had gradually increased in size until it occupied the upper half of the left orbit. The mass extended from the upper margin of the internal rectus across the globe to the external rectus and backward indefinitely. The mass was accommodated by an absence of the middle third of the orbital ridge and roof, together with a fenestrum in the external orbital wall. Dissection of the mass was most tedious. The base rested on the upper outer aspect of the globe and was quite adherent to the sclera. Histologic study showed no capillaries or glandular elements, no cysts or signs of degeneration.

Boot observed a female, aged 21 years, with an angioma of the orbit. The first evidence of the trouble began about nine months previous. Latterly the mass had markedly increased in size. There was a soft swelling at the inner part of the orbit; the upper eyelid was swollen. There was a distinct thrill felt and bruit heard. The growth did not extend into the nose. X-ray pictures showed no evidence of erosion. The reporter discusses the various types of this class of tumor, their infrequency and possible appropriate methods of treatment.

An unusual orbital tumor was removed by Wheeler by the Krönlein method. A female, aged 40 years, gave a history dating back ten years, at which time she observed a small, red spot in the right eye. At the time of examination, there was a large subconjunctival hemorrhage and a decided protrusion in the region of the lachrymal gland. Operation revealed a jellylike mass adherent to the lachrymal gland and outside the muscle cone. A small area of the upper part of the temporal wall of the orbit was deficient. Dixon considered this to be a hemorrhagic form of degenerating connective tissue tumor; Weeks, probably sarcoma; Verhoeff, an unusual form of hemangioendothelioma.

Primary sarcoma of the orbit with anterior adhesive iridocyclitis is reported by Ischreyt. Exenteration revealed a necrotic sarcoma with a large cyst. In the enucleated eye, there was a close attachment of the root of the iris to the cornea and sclera. In spite of this fact, the tension was not increased but diminished. In Posey's patient with sarcoma of the orbit, the eye had been enucleated elsewhere four years previously, perhaps for sarcoma of the choroid. The recurrence in the orbit was a firm, black mass occupying the position of the eyeball. Exenteration was followed by marked hemorrhage, which ceased upon the application of the Clark method of desiccation. Zentmayer observed a growth in the orbital fold of the left eye. The mass, 40x25 mm., extending from midline to the external canthus; it being encap-

sulated, was easily removed through an incision. Microscopic examination showed a predominance of large round sarcoma cells.

Darier reports a case of melanosis of the orbit which began as a small conjunctival speck. Ophthalmoscopically pigmented points in the retina, which had been noted, were found to be connected with the mass by means of vascular filaments. Thirteen months after extirpation there had been no recurrence.

A tentative diagnosis of an ethmoid osteoma was made by Sattler, following an exploratory operation. A lad, aged 14 years, during the preceding two years, had noticed a prominence of the left eye. Two months prior to his first visit, the protrusion became more pronounced. Through a Krönlein incision, a very thorough examination of all parts of the orbit was made. An extremely hard protrusion of inner and upper wall was discovered, and the globe was enucleated to permit an easier access to the region of the ethmoid or sphenoid bones. After careful consideration it was determined not to proceed with the removal of the small and probable osteoma, but await results of future observation.

Zentmayer exhibited from the service of Chance, a probable case of malignant growth of the antrum. The patient, a female aged 60 years, had a firm, ridgelike mass palpable just within the inferior orbital margin. A thorough examination of the patient had not been completed.

E. H. Cary (*Journ. Am. Med. Assoc.*, Oct. 30, 1915; reviewed in *Annals of Ophthalm.*, p. 327, Apr., 1916) recommends the starvation method of treating malignant tumors of the orbit. The author quotes briefly the results of ligation of arteries for malignant growths in the general surgical literature, and reports in detail fifteen cases, mainly sarcoma in various parts of the face and neck, with nine cases of carcinoma. His conclusions are as follows: 1. (a) All branches of each external carotid must be tied. (b) In the majority of cases both sides can be operated on with an interval of two weeks, and this without shock. (c) Sarcoma offers the best results. 2. It may be noted that all the sarcomas occurred on the left side except two. As the common carotid arises from the transverse portion of the aorta, a mortified enlargement might find nourishment in excess from this circumstance. 3. Circulation from the ophthalmic branch of the internal carotid does not prevent the value of the operation in the orbit, as Dawbarn concluded. 4. In this group of cases sarcoma occurs in all ages. In females it occurs most often beyond the age of nineteen, and in males, under this age. 5. Cancer occurs in this group oftener in males and only in one case under forty-six years of age, which was

one reported example of eukeroid disease, aged twenty-eight years. (Sarcoma). 6. Cary has not found in any of his cases an anomaly in the carotid distribution. 7. The results seem best when the tumor is not disturbed, suggesting traumatism at the site always an exciting factor. 8. Though he has not practised ligating uniformly the accompanying veins, it may be better to do so. 9. Although certain carcinoma cases were treated with the Roentgen ray, no good results were observed. 10. In two cases in which tumors involved the optic nerves, both demonstrate that the optic nerve tracts reach the chiasm and there decussate: when a nerve proceeds to its destination, the respective nasal half possibly, and the temporal half probably, are separately sheathed, as is also the papillomacular bundle of fibers, which are intact and which may be disturbed but not destroyed. The author's observation has been that a distinct deterring influence is exerted in carcinomatous growths, but that is the best that can be said.

Wm. Lang and Donald Armour (*Am. Jour. Ophthalm.*, 1919) reported a case of ivory exostosis of the orbit removed through the cranium. Armour said the surgical problem in this case was one of operative approach i. e., by what means the tumor could be reached and completely removed without doing damage to the cranial or orbital contents, and quite secondarily, to ensure that there should not be much disfigurement afterwards.

After seeing the skiagram, he concluded that the best approach would be through an osteoplastic flap turned over the frontal region, with its base at the supraorbital margin, turning down scalp and bone together. He did so, and that gave him a view of the cranial portion of the tumor, which was found to be indenting the under-surface of the frontal lobe. On pushing brain and dura gently back, he could see the whole extent of the cranial portion of the tumor. It at first appeared to be fixed to the supraorbital margin, but it was not so.

It was removed mainly by hammer and chisel, but the orbital roof portion was got away by means of cutting forceps, piecemeal. Complete recovery ensued: very little scarring remained, vision was normal, and there was neither diplopia nor fundus change. The tumor must have been growing from the frontal sinus. There was no evidence that the operator had broken into that sinus: he was looking out for such a contingency, from the point of view of possible sepsis, and also impediment to respiratory movements. On the day following the operation, however, and for a day or two succeeding, there was some escape of blood from the nostril. But the frontal sinus was evidently aseptic, as there was no further happening.

TUMORS OF THE OCULAR MUSCLES.

There seems little in the literature of the subject to add to the matter on p. 8253, Vol. XI of this *Encyclopedia*. See, also, *Sarcoma of the orbit* in this section.

Tungsten. WOLFRAM. Apart from the use of calcium tungstate in skiagraphy, the interest in the metal for ophthalmologists lies in its extensive use in electric lighting filaments.

The *Electrical World*, p. 1057, May 6, 1916, gives *suggestions on the use of reflectors in connection with gas-filled tungsten lamps both for interior illumination and for street lighting*.

The increased intrinsic brilliancy of the modern nitrogen-filled tungsten lamp, owing to the reduced area of the light source, is sometimes considered a disadvantage. Haydn T. Harrison (*Electrician*, Mar. 17, 1916) proposes, however, that this increased intrinsic brilliancy be utilized by combining the lamp with a reflector. He even suggests that the makers of gas-filled lamps should coil the filament as closely together as possible in order to concentrate the light source so that the lamps will lend themselves to more efficient handling by means of reflectors.

He argues that the desire to avoid glare is very natural, but that the impression held generally—that the particular cause of glare is the high intrinsic brilliancy of a light source—is wrong. In the author's opinion this is not the fact, for the following reason: If a 10-in. diameter motor-car headlight, producing, say, a maximum of 5000 cp. is compared with an arc lamp which, when inclosed in a 10-in. opalescent globe, also gives 5000 cp., the headlight will appear to be much more glaring than the arc lamp, although the intrinsic brilliancy of the source is the same. The difference lies in the fact that the apparent intrinsic brilliancy of the source tapers off in one case to nothing, whereas in the case of the headlight it ceases nearly abruptly. Thus there is a means of reducing the unpleasant effect of glare without necessarily reducing the high intrinsic brilliancy of the source, namely, by gradually accustoming the eye to the brilliancy.

In considering a *lighting problem*, the first point to settle is the degree of intrinsic brilliancy of a light source that is harmless and pleasant to the eye. It may be assumed that a shallow glass bowl, equally illuminated all over, would be suitable for an average room. For example, a room 15 ft. square by 12 ft. high would require $15 \times 15 \times 2 = 450$ lumens to produce an average of 2 ft.-candles. If this average were taken at 2 ft. 6 in. above the floor and the light source were 2 ft. 2 in. below the ceiling, these lumens would be directed over

a solid angle of about 90 deg. Now, a modern gas-filled electric lamp distributes light equally in nearly all directions. Therefore it will produce lumens equal to 4π times the candle-power, and the candle-power required will be $450 (4\pi) = 36$, to which must be added certain losses to be considered later, when it has been decided how best to direct the luminous flux over the desired angle.

The method that naturally suggests itself is the use of a reflector that will collect the rays over an angle of 270 deg. and direct them over an angle of 90 deg. But this would mean that, within the angle of 90 deg., the lamp would be visible, and that the only light outside the 90 deg. would be that reflected from the surroundings. Both of these conditions are unpleasant, therefore a diffusing bowl is necessary, and the author suggests one 9 in. in diameter. Having designed the reflector for a spread of 90 deg., if below it were placed a diffusing glass three things result: (1) The visible area of the light source is increased; (2) a loss due to absorption occurs; (3) further diffusing of light occurs. The visible area of the light source is increased to something over 63 sq. in., depending on the depth of the bowl. Therefore the intrinsic brilliancy of the light source is reduced to less than 4 cp. per square inch, which is about the same as a flat-wick petroleum-lamp flame, generally admitted to be a pleasant light. Thus one of our objects has been attained. The degree of diffusion or dispersion will depend largely on the type of glass used. The depth of the bowl can be regulated to obtain a pleasant but small illumination on the walls up to the height of the light source, which will again be reflected from the walls to illuminate the ceiling sufficiently to cause a good effect. Moreover, the amount of side diffusion can be largely regulated by designing the reflector to concentrate the light in a downward direction; in other words, to produce a nearly parallel beam.

In his work in the Navy the author has been able to produce reflectors which, with a dispersion of 6 deg., produce a mean candle-power about 1000 times that of the original lamp. Let us suppose that such a reflector had been used in the case of the 9-in. fitting previously referred to. Little of the total light flux would then have been lost in the reflector, therefore the only loss would have been the glass absorption. The position of the light source being suitable for distribution in the room, an efficient and pleasing illumination would result, even when using a lamp of a high intrinsic brilliancy.

Harrison then takes up *street lighting*. The distance at which an object is visible from a motor car using a headlight of moderate power, is in itself proof that the lighting of roads could be more efficiently

carried out without increasing the cost. A 32-cp. lamp provided with a suitable reflector will produce a beam by which a dark-colored object can be seen at a distance of 750 ft. This is to say, with lamps 250 yd. apart illuminating conditions could be produced which would insure public safety, whereas the conditions now are such that with lamps of similar power placed 70 yd. apart the illumination is so bad that traffic is often dangerous.

To suggest that two 32-cp. lamps erected on lamp posts at a distance of 750 ft. would be an improvement on the present method of putting a 60-cp. lamp at distance of 50 to 70 ft., will strike those who have not considered the matter as ridiculous. Nevertheless drivers of fast vehicular traffic rely entirely on the light produced by their own headlights. It is, however, common knowledge that the headlights of vehicles produce glare which might prove a serious drawback to the adoption of concentrated light for street or road lighting purposes. In the case of public lighting there is another means of reducing it, namely, by placing the light sources at such a height that the most powerful rays are only within the line of vision when the lamps are viewed from a distance, and as the observer nears the light source of the candle-power of the beam reaching his eye is reduced.

See, also, **Simpson light**.

Tunica adnata oculi. (L.) An old term for the ocular conjunctiva.

Tunica alba. (L.) An old term for the sclerotic.

Tunica albuginea. Tenon's capsule.

Tunica albuginea oculi. (L.) The sclerotic.

Tunica candida. (L.) An old term for the sclera.

Tunica chorioidea. (L.) The choroid.

Tunica conjunctiva. (L.) The conjunctiva.

Tunica conjunctiva bulbi. The conjunctiva of the eyeball; the bulbar or ocular conjunctiva.

Tunica conjunctiva palpebrarum. An old term for the conjunctiva of the lids; the palpebral conjunctiva.

Tunica cornea opaca. (L.) An ancient term for the sclera.

Tunica cornea pellucida. (L.) A name for the cornea.

Tunica demoursiana. (L.) A synonym of the membrane of Descemet.

Tunica dura. (L.) The sclera.

Tunica extima. (L.) The sclerotic.

Tunica fibrosa oculi. (L.) An old name for the combined cornea and sclera.

Tunica innominata. (L.) (Obs.) The sclera.

Tunica interna oculi. (L.) The retina.

Tunica Jacobi. The bacillary layer of the retina.

Tunica nervi optici externa. (L.) The outermost layer of the sheath of the optic nerve, derived from the dura.

Tunica oculi dura. (L.) A name for the sclerotic.

Tunica optici interna. (L.) The innermost layer of the sheath of the optic nerve, derived from the pia.

Tunica perforata oculi. (L.) The choroid.

Tunica reticularis (seu retiformis) oculi. (L.) An old term for the retina.

Tunica rhagoides. (L.) (Obs.) A name for the choroid.

Tunica ruyschiana. (L.) MEMBRANA RUYSCHIANA. The internal layer of the choroid.

Tunica sclera bulbi. (L.) An old name for the sclerotic.

Tunica uvalis. TUNICA UVEA. TUNICA UVIFORMIS. Old and rarely used synonyms of the uvea, or uveal tract.

Tunica vaginalis oculi. A rarely used synonym for Tenon's capsule.

Tunica vasculosa choroideæ. (L.) Uveal tract.

Tunica vasculosa Halleri. An old name for the choroid coat.

Tunica vasculosa lentis. A vascular envelope, made up of the various vascular projections of the embryonic cephalic plate, completely surrounding the crystalline lens in the embryo.

Tunica vasculosa oculi. (L.) One of the many synonymous terms for the choroid.

Tunica vitrea. (L.) Hyaloid membrane.

Tunic, Choroid. The choroid membrane.

Tunmer, Robert James. A well known English physician, of considerable reputation in ophthalmology, although he never devoted himself exclusively to that subject. He was for a long time clinical assistant at the Royal Westminster Ophthalmic Hospital. He died at Fulham, London, England, Dec. 13, 1905, after a long and painful illness.—(T. H. S.)

Tunnel anemia. ANKYLOSTOMIASIS. DIRTEATER'S ANEMIA. HOOKWORM DISEASE. See *Ankylostomum duodenale*, p. 490, Vol. I; under *Ankylostomiasis*, p. 487, Vol. I; also *Uncinariasis* and *Hookworm disease*.

Tunny fish. In ancient Greco-Roman times, the liver of a tunny fish was highly esteemed as a means of preventing the return of cilia after epilation. First, the lashes were painted with oil of cedar, then they were pulled out, and the tunny fish liver was applied to the epilated portion of the lid margin.—(T. H. S.)

Turnbull, Alexander. A celebrated Scotch ophthalmologist, whose life-dates are unknown. He received the degree of M. D., however, at

Edinburgh in 1820; and, in addition to works of a general character, wrote the following:

1. *A Treatise on Painful Nervous Diseases, more Especially on the Discovery and Application of Many New Remedies for Affections of the Eye and Ear.* (1837.)

2. *Treatment of the Diseases of the Eye by Means of Prussic Acid Vapor and Other Medical Agents.* (London, 1834.)—(T. H. S.)

Turnbull, Charles Smith. An ophthalmologist and oto-laryngologist of international reputation. He was born at Philadelphia, Nov. 10, 1847, son of Dr. Laurence and Louisa Paleska (Smith) Turnbull. He received the A. B. at the Central High School, Philadelphia, in 1868, the A. M. in 1869, the Ph. D. at the University of Pennsylvania in 1871, and the medical degree at the same institution two years later. In 1874-5 he studied the eye, ear, nose and throat at the University of Vienna.

Dr. Turnbull was surgeon to the U. S. Geological Survey in Wyoming and Montana in 1872 and of the Yellowstone Park in 1871-72; resident surgeon to the New York Ophthalmic and Aural Institute in 1873-75; chief of the aural department at the Jefferson Medical College for ten years; oculist and aurist to the German Hospital, Philadelphia, for more than thirty-five years, and for many years to other leading Philadelphia hospitals. He served in the Civil War in the 119th Pennsylvania Volunteers, and, since 1900, was Surgeon Major of the First Infantry, N. G., Pennsylvania.

Dr. Turnbull married, Oct. 18, 1877, Elizabeth Claxton, of Philadelphia, by whom he had three daughters, Mrs. Hamilton D. South, Mrs. M. R. Goldsborough, and Mrs. Nelson P. Vulte. Dr. Turnbull died of pneumonia at his home, 1935 Chestnut St., Philadelphia, Feb. 21, 1918.

He was the author of numerous articles on ophthalmology and otology, and also translated from the German Arlt's *Injuries of the Eye Considered Medico-Legally*, Gruber's *Tenotomy of the Tensor Tympani Muscle*, and Bruner's treatise *On the Methods of Connection of the Ossicles*.—(T. H. S.)

Turnbull, Lawrence. A celebrated American ophthalmologist and otologist, the first in the United States to perform a perforation operation on the mastoid cells. He was born in Scotland, Sept. 10, 1821, but came to America when only twelve years old. Turning his attention first to pharmacy, he graduated at the Philadelphia College of Pharmacy, and, for a number of years, was a practising pharmacist. His medical degree was received at Jefferson Medical College in 1845. After a term of service as resident physician at the Blockley Hospital,

Philadelphia, he was elected in 1857 as ophthalmologist and otologist to the Western Clinical Infirmary, afterward the Howard Hospital, in which capacity he served for thirty years. In 1859 he studied his specialties in London, Dublin, Edinburgh, Paris, Vienna and Berlin. He served during the Civil War as a Volunteer Surgeon. In 1878 he became otologist to the Jefferson Hospital. He married, in 1839, Louisa Paleske, daughter of Col. Chas. S. Smith, of Philadelphia. He died in Philadelphia, Oct. 24, 1900. Among his writings are *Defective and Impaired Vision* and *Hints on Military Hygiene*. Most of them, however, relate to otology.—(T. H. S.)

Turpentine. SPIRITS OF TURPENTINE. OIL OF TURPENTINE. GALIPOT. This agent is an oleo-resin derived from several coniferæ; a greenish, translucent, viscid liquid with a peculiar aromatic odor and a hot, pungent taste, soluble in alcohol.

Turpentine is chiefly employed in local applications to the eye as a stimulant to absorption of corneal opacities. Königstein dilutes it one-half with almond oil for this purpose. A single drop is instilled into the eye which is then covered by a protective and the ensuing hyperemia watched. Undue irritation should be avoided, especially as the treatment may have to be continued for several weeks.

Turritum caput. See **Tower-skull**.

Tutamina oculi. The defenses or protective appendages of the eye; the lids, lashes, etc.

Tuyau monture de l'objectif. (F.) Lens tube.

Twilight. If the earth had no atmosphere we should be involved in total darkness from the instant of sunset until the instant of sunrise or dawn. The transition from day to night, and from night to day, occupies an interval which varies with the latitude and the declination of the sun, and this intermediate stage is called twilight. As long as the sun is not more than 18° below the horizon its light is reflected by the air and the clouds and vapor suspended in it in sufficient quantity to render even distant objects visible. The question of the duration of twilight is, therefore, simply reduced to this: How long after sunset, or before sunrise, does the sun reach a position 18° below the horizon of a given place? And this can be answered easily by calculation in spherical trigonometry. It may happen that the sun, at certain seasons and in certain places, is never more than 18° below the horizon between sunset and sunrise. In this case the sun will set and rise, but there will be no night, or, rather, twilight will occupy the whole interval from sunset to sunrise. This cannot occur in low latitudes, but does occur during certain periods of the year in northern and southern countries. In lat. $48^\circ 30'$ ($72^\circ - 23^\circ 30'$) there will be

one night in the year (at the summer solstice) consisting wholly of twilight; for higher latitudes, more; and for lower, not one.— (*Standard Encyclopedia*.)

See, also, **Starlight**.

Twin colors. A set of two fundamental colors that appear identical to the color-blind.

Twin cones. In comparative anatomy, retinal cones which are united by their lateral surfaces, the rods and fibres being separate.

Twin knives. The name commonly given to the two instruments devised by Wm. Lang for the division of anterior synechiæ. See p. 3326, Vol. V of this *Encyclopedia*; as well as under **Synechotome**.

Twin scissors. The instrument used by Bishop Harman in his sclerotomy operation for glaucoma. (q. v.)

Twisted suture. See **Suture, Twisted**.

Two-cell contraction. In alphabets and print for the blind (q. v.), in some cases, a character in Braille immediately preceded by one of the characters formed in the second column of the Braille 2 x 3 area, is used to represent a group of letters, thus using two cells for one contraction.

Two-level line. In alphabets and print for the blind (q. v.), this is the plan in which all the dots are on an upper and a lower line, as in New York Point.

Tyloma. A callus; a callosity.

Tyloma conjunctivæ. This term was applied by Gallenga and Best (*Beiträge zur Augenheilk.*, Vol. 34, 1899) to the advanced or epidermoid form of *sclerosis conjunctivæ* (q. v.).

Elschnig (*Oph. Year-Book*, p. 126, 1909) calls attention to a form of chronic conjunctival irritation sharply defined and clinically easy of recognition, but practically unmentioned in literature. It is due to "absolute or relative insufficiency of the eyelids," which prevents their closure except by effort, and allows the lids to remain open in sleep. By atmospheric and mechanical action the exposed area of conjunctiva becomes dry, and the seat of a chronic inflammation, which spreads to the rest of the membrane. In obstinate cases xerosis of the conjunctiva results, a condition called by Saemisch *tyloma conjunctivæ*. Treatment consists in protection of the eyes at night, rubbing 2 to 4 per cent. boric acid in lanolin into the conjunctival sac, and in severe cases bandage or protection mask. During the day frequent voluntary closures of the lids should be carried out. Astringents are barred.

Tylosis. A chronic inflammation of the margin of the eyelid, in which the whole substance of the lid along the margin is thickened and hardened.

Hiwatari (*Ophthalmology*, p. 188, Oct., 1913) cured a case of tylosis of the inflamed lid border by epilation of the cilia and brushing with 10 per cent. pyoktanin solution.

Types (in printing), Ocular relations of. See **Typography**.

Types, Test. See **Test charts**.

Typhloid. Having genetically defective vision, as in a mole or a blindworm.

Typhlolexia. Word-blindness.

Typhlogy. The sum of scientific knowledge concerning blindness.

Typhlophile. A friend of the blind. One of the best known typhlophiles was the ophthalmologist, Javal, himself blind. (See **Javal**, in this *Encyclopedia*.)

Typhlops. (L.) Blind; a blind person.

Typhlosis. Blindness.

Typhlotes. (L.) Blindness.

Typhlotriton spelæus. The blind salamander. See p. 1121, Vol. II, of this *Encyclopedia*.

Typhlótrophium. (L.) An asylum for the blind.

Typhoid fever, Ocular symptoms of. These are by no means constant, although quite a number of eye lesions have been recorded as accompanying or resulting, from typhoid infection. As examples of early records, Panas (*Archives d'Ophthalm.*, 15, 1895) published the discovery of typhoid bacilli in orbital pus, while Gower's (*Med. Ophthalmoscopy*, p. 280) reported a case of medium papillitis following typhoid.

Weeks (*Treatise on Diseases of the Eye*, p. 764) notes that among the rare complications are conjunctivitis, keratitis, embolism of the retinal arteries, optic neuritis, optic-nerve atrophy, panophthalmitis, thrombosis of the orbital veins, cataract, and paresis of the ocular muscles. He adds that since the typhoid bacillus is present in all the tissues of the body to a greater or less degree, it is not strange that manifestations in the eye, particularly those connected with the blood-vessels, are not uncommon. Retinal hemorrhage occurs fairly frequently (Bull, *Med. News*, April, 1897). Inflammation of the uveal tract is rare. In the later stages of the disease enophthalmos from wasting of orbital tissues, superficial and sometimes deep and extensive keratitis from inefficient closure of the lids, and diminished accommodative power are experienced.

Of 1138 cases of typhoid (Adamuck, *Petersburg. med. Woch.*, 1894, 38 and 39) ocular affections occurred in 32. The choroid was affected most frequently.

Typhoid fever possesses some therapeutic value, according to Todd

(*Ophthalm. Record*, Jan., 1906) who noted the disappearance of trachoma and dense pannus during the course of a severe attack of typhoid fever in a young woman.

Paul (*Prac. Med. Series, Eye*, p. 186, 1907) reports a case exhibiting *septic retinal changes in typhoid*. In a patient, aged 22, shortly before death, small, whitish, round foci of the size of $\frac{1}{2}$ disc, close to the larger vessels, encircling the disc at some distance, were found. The macular region was free. Besides, there were large and small hemorrhages, but the vessels showed no changes. Twenty hours after death the eyes were enucleated and the following conditions noted: The foci were exclusively located in the layer of the nerve fibers in the immediate neighborhood of the vessel. The layer was thickened from local edema of the retina and varicose hypertrophy of the nerve fibers, but there was no infiltration with small cells at the foci.

Paul considers the condition to be of toxic origin. As the same kind of foci have been observed in sepsis, first described by Roth, the author is in doubt whether these foci, retinal hemorrhages, etc., are to be attributed to a direct action of the specific bacterial toxin or to toxic substances, generated by the organism under the influence of these toxins. They certainly are rare in typhoid, since Heine found only this case out of 82, examined ophthalmoscopically.

Holtz described *circumscribed purulent foci in the choroid*. Retinal hemorrhages and optic neuritis have been observed rather frequently, but none of the authors saw these whitish, retinal particles, which on the other hand have been observed besides septic affections in other diseases of the blood. The bacteriological findings were negative.

V. Arnold (*Wiener klin. Woch.*, Aug. 17, 1911), in 14 cases of typhoid fever found 8 marked and 2 slight cases of *optic neuritis*, the inflammation usually occurring about the end of the first or the beginning of the second week without marked subjective symptoms. This complication outlasted all other symptoms, but no unfavorable results were observed.

Optic neuritis being quite a rare complication of typhoid fever, its discovery in doubtful cases becomes of diagnostic importance. In no other acute infectious disease, excluding meningitis, does optic neuritis apparently occur so frequently. Further observations are necessary, however, to substantiate these views.

N. Kumagar (*Centralbl. f. prak. Augenheilk.*, Sept., 1912), reports a case of *paralysis of the superior oblique in the course of typhoid fever*. The patient was a man, aged 28 years, who at the end of the third week of an otherwise mild but definite attack of typhoid fever, developed double vision. The eyes were examined four weeks after

the onset of the diplopia and were found to be normal in every respect except for a paralysis of the right superior oblique. The condition cleared up in about seven weeks.

Discussing the etiology of this case, Kumagar comes to the conclusion that the lesion was a peripheral neuritis of the fourth nerve and not a waxy degeneration of the muscle or a cerebral condition.

Ginestous claims that only six or seven cases of ocular paralysis following typhoid fever are on record. In two cases the sixth nerve was affected. Ginestous used mixed treatment in his case without result.

F. C. Layson (*Ophthalm. Record*, July, 1914) describes *conjunctival hemorrhage in typhoid*. A patient, aged 25 years, suffered from typhoid fever with repeated hemorrhages from the nose, intestine, and kidneys. Plugging of the nares for epistaxis was followed by hemorrhage in the conjunctival sac. This bleeding arose from the conjunctiva of the upper lid and was capillary and profuse but was controlled by moderate pressure. The hemorrhage stopped after the administration of normal horse serum hypodermically. At a later date, the remains of four small hemorrhages were seen in the retina. There was no history of a hemorrhagic diathesis.

Typhoid fever, Ophthalmic test for. As an appendix to the matter on p. 9051, Vol. XII of this *Encyclopedia*, is an editorial (*Journ. Am. Med. Assocn.*, Feb. 17, 1912) on this subject: Austrian (*Bull. Johns Hopkins Hosp.*, xxii, 1, 1912) has described an ophthalmic reaction in typhoid similar to that described in 1907 by Chantemesse (*Deutsch. med. Wchnschr.*, xxxiii, 1246 and 1572, 1907). That observer obtained positive results in each of seventy cases of typhoid and negative results in forty-nine of fifty control cases. Floyd and Barker (*Jour. Med. Research*, lvi, 1417, 1909), using a modification of the same technic, obtained positive reactions in 96 per cent. of typhoid cases and negative results in 84 per cent. of controls. Other investigators have obtained a variety of results in both typhoid and control cases, and some have concluded that the reaction is not specific. Others attributed the various results to a difference in strength of the extracts of virulent typhoid bacilli which were used as an antigen in the reaction. Austrian advances the hypothesis that the patient develops a sensitiveness toward the predominating strain of the organism with which he is infected, and a relatively small degree of sensitiveness toward other strains, just as a patient produces immune bodies in large amount against the strain with which he is infected and has relatively few antibodies against other strains. Acting on this hypothesis he prepared antigen for the reaction from a mixed

culture of eighty different strains. These were grown in plain bouillon for twenty-four hours and were then sedimented, washed, and killed by heating for two hours at 60 C. The mass of bacilli was then thoroughly dried and ground with sodium chlorid crystals in an agate mortar, after which it was macerated with water for three days and the watery extract precipitated by pouring into absolute alcohol. The residue was then collected, dried, pulverized, and a solution made in the proportion of 10 mg. to 1 c.c. of water. One drop of this solution dropped into the lower conjunctival sac of the typhoid fever patient produced a mild inflammation with reddening of the conjunctival membrane, and sometimes slight edema of one or both eyelids. The reaction reached its height in from six to ten hours, and the symptoms even when marked were not sufficient to cause the patient to complain of discomfort.

The report shows extensive charts in which this reaction is compared with blood cultures and agglutination tests in seventy-five cases diagnosed clinically as typhoid fever. The test was positive in seventy-one and negative in four—a much larger proportion of cases than were positive by either blood cultures or agglutination. Of nineteen tests made during the first week of the disease eighteen were positive, and the nineteenth gave also negative results by both blood-culture and agglutination reaction. Positive reactions were often secured from the third to the fifth day and in a few cases as early as the second day of the disease. In 190 controls including a great variety of febrile and afebrile conditions and twelve normal adults the ophthalmic reaction was absent without exception. The reaction was found to be present most often during the acute febrile stage, and absent most frequently during convalescence.

Austrian claims the following advantages: The technic is very simple, requiring no complicated apparatus, presupposing of course that the antigen is furnished from reliable laboratories. It is a bedside test and is available during the early stages of the disease. It causes the patient less inconvenience probably than does the taking of blood for other diagnostic purposes. Its results more closely parallel those of blood cultures than do those of the agglutination test. If the ophthalmic reaction can establish these claims it needs no other recommendation to secure its general acceptance into clinical use.

This reaction has been the subject of papers by Orszag and Hamburger (*Oph. Year-Book*, p. 53, 1909). The latter obtained it in 27 cases, diagnosed as typhoid clinically and by the agglutination test; and at all stages of the disease from 5 days to the tenth week, but not

earlier than a positive result with the agglutination test. He also got the reaction in three cases diagnosed clinically as typhoid without use of the Widal test. In 15 cases of other diseases the specific reaction was not obtained. In three cases diagnosed clinically as typhoid, but giving no agglutination, the conjunctival test was negative.

Typhoid inoculation, Ocular complications of. de Lapersonne, (*Arch. d'Ophtal.*, March-April, 1917) states that although a certain number of cases of ocular lesions after inoculation have been noted, only a small proportion of the observations are worthy of credence. Among the cases which have been carefully observed it is essential to distinguish between those in which the vaccine may be held responsible, and those in which another and coincident cause exists. In the latter category are to be placed cases of septic infections (staphylo-, strepto-, and pneumo-coccal) following inoculation and due to faulty methods of preparation or administration of the vaccine, or to latent infection in the patient. The writer cites an instance of such infection in a soldier in whom multiple boils, bronchopneumonia, and metastatic purulent irido-cyclitis occurred as a sequel to anti-typhoid inoculation. Cases of this nature are extremely rare; they should, nevertheless, be made public in order to emphasize the necessity for the strictest attention to asepsis, and a thorough clinical examination of the patient before inoculation.

de Lapersonne holds that in some cases the vaccine, apart from any extraneous source of mischief, may be responsible for ocular lesions, e. g., irido-cyclitis. He suggests, as not impossible, that in an eye which has previously been diseased, the severe reaction of anti-typhoid inoculation may excite a recurrent attack of inflammation, and that this is especially likely to occur in a tissue so richly vascular as the uveal tract.

He summarizes his opinions as follows: 1. Infections resulting from faulty technique, often serious in character, are not due to the direct action of the vaccine. 2. Anti-typhoid vaccine has given rise, directly, to a very small number of ocular lesions, notably to corneal herpes (ascribed to toxic neuritis of the trigeminal), and to irido-cyclitis in patients with constitutional taint. Glaucoma, secondary to irido-cyclitis, may develop during the reaction which follows vaccination. 3. No instances of definite lesions of the optic nerves or tracts or of oculo-motor paralysis have been recorded. 4. Primary acute glaucoma may develop during the vaccination reaction. 5. No lesion should be ascribed to inoculation which does not arise during or very shortly after the series of injections, and while the ther-

mometer affords evidence of a severe reaction. 6. An ophthalmoscopic, in addition to a medical, examination, should be made before inoculation. It is inadvisable to submit to inoculation, syphilitic, tuberculous, or arthritic subjects over 40 years of age who have had lesions of the uveal tract.

Prélat (*Archives d'Ophthalm.*, Nov., 1917; abst. *Br. Journ. Ophthalm.*, Aug. 1919) has written a carefully prepared statement of a case of *bilateral irido-cyclitis during typhoid inoculation*. The patient was sent to the Tenth Ophthalmological Centre of the French Army, labelled, "Iritis occurring three days after a second antityphoid injection; transient albuminuria followed the first injection." An interval of two weeks separated the two injections.

When he came under observation on January 24 he had acute bilateral irido-cyclitis with severe subjective symptoms. The conditions became aggravated during the next few days, and on February 5 there were visible in each iris numerous vascular nodules, mostly situated near the peripheral border; a fine precipitate covered the lower half of the posterior surface of each cornea.

The Wassermann reaction was strongly positive and a definite history of a primary syphilitic lesion seven months previously was forthcoming. The disease rapidly subsided under active anti-syphilitic treatment.

Prélat concludes his article with the following remarks:

Antityphoid inoculation in syphilitics free from disease of the anterior segment of the eye appears to be devoid of risk. If in such patients ocular lesions develop during the inoculation treatment, the latter should not be held responsible for the complication. On the other hand it is prudent, as advised by de Lapersonne, to abstain from antityphoid inoculation in syphilitic subjects who have had lesions of the uveal tract, which might be excited to recrudescence by the action of the vaccine.

In view of the medico-legal difficulties which might arise in these cases, ocular complications which may develop during a course of antityphoid inoculation should not be attributed to the treatment, except after a complete and accurate examination of the patient; such etiology should be accepted only with great circumspection, and after a thorough sifting of all available evidence.

Typhophthalmia. Ophthalmotyphus; see p. 9051, Vol. XII of this *Encyclopedia*.

Typhus fever. According to Parsons (*Pathology of the Eye*, p. 1327) Larionow (*Klin. Monatsbl. f. Augenheilk.*, 16, 1878) collected cases of conjunctivitis, keratitis, iritis, retinitis, papillitis, night-blindness,

and other complications of typhus. In 253 cases of optic neuritis due to infectious diseases, three, according to Uhthoff, resulted from typhus fever. Choroiditis, metastatic ophthalmia and bilateral dacryoadenitis are also reported.

A. Torres Estrada (*Observador Médico*, Oct., 1919; abst. *Journ. Am. Med. Assocn.*, Jan. 3, 1920) has reported six cases of typhus in which syphilis was associated with the eye symptoms. In all they resembled closely the lesions of syphilis. The optic neuritis progressed to blindness in four of the six cases. One of the others had inherited syphilis, and after having been totally blind for a time after the typhus, under mercury and iodid he regained considerable visual acuity in both eyes. Torres witnessed also a number of similar cases of optic neuritis following influenza, and retrogressing likewise under specific treatment.

Typhus, Hepatic. See **Spirochetosis**.

Typical lenses. See p. 7240, Vol. X, of this *Encyclopedia*.

Typography. The arrangement of composed types; also the appearance and form of printed matter. Books and newspapers should not be printed in type smaller (nor closer-set) than that shown on p. 3188, Vol. V, under the heading **Conservation of vision**, of this *Encyclopedia*, and represented by the composition hereof.

Typometer. A name employed by Bishop Harman (*Oph. Year-Book*, p. 25, 1913) for a fine, accurate scale, to be used under a magnifying power to measure the exact size of type.

Typoscope. A device invented by C. F. Prentice to exclude all extraneous light from the field of fixation, thus securing better definition and increasing the visual acuity. The inventor says (*Ophthalmic Lenses*, pp. 183 and 184): In cases of ametropia and amblyopia it is frequent that increased illumination reduces the definition, owing to a superabundance of extraneous light, which serves to reduce the contrast within the polar field of fixation. In optical instruments it is found practicable to exclude peripheral extraneous light by means of a diaphragm of suitable aperture, and it is even possible to increase the definition, through limiting the field in an inferior instrument by further reducing the size of this aperture. Thus it is that the pin-hole disk heightens the visual acuteness in ametropes who view objects at a distance through it. While the same proportionate improvement can be obtained in a similar manner at finite distance, yet it would be exceedingly difficult accurately to place the pin-holes before the pupils of both eyes for reading binocularly. To obviate this impracticability, while still securing an unimpaired field of fixation, the typoscope, as here described, seems in many instances effectively to serve its purpose. It

consists of a rectangular plate of hard rubber, or black cardboard, 7 by $2\frac{1}{4}$ inches, provided with an aperture $4\frac{1}{4}$ by $\frac{3}{8}$ inches, centrally located, though laterally displaced so as to leave sufficient of the plate, two inches, to be conveniently held between the thumb and fingers, when it is placed upon the book or paper, and while it is being slid down over the column in reading. The central aperture is just deep enough to allow two lines of brevier type to be viewed at a time, and wide enough to take in the width of an average column of type, as shown in the diagram. The author has found it to be especially serviceable to cataract patients and amblyopes wearing high corrections. The former, who notably suffer greater impairment of vision from extraneous light, are invariably enabled with their glasses to read the smallest type by the aid of the typoscope, which excludes all light reflected from the surface of the paper, except that which actually affords them the necessary contrast between it and the type within the slot. The device is exceedingly simple, inexpensive, and easily carried in the pocket. Its utility is easily demonstrated by first ascertaining the size of the smallest type which the patient reads with glasses, and then allowing the patient to use the typoscope in addition to them, for the purpose of ascertaining whether smaller type can be read, or not. Even in the latter case it has been the author's experience that patients using the typoscope claim to read with less sense of confusion.

Tyrosin. As to the presence of tyrosin in the choroid Cirincione (*Clinica Oculistica*, July and August, 1915) states that the presence of iron in the molecule of many melanins raises the question whether such melanins should be considered as products of the transformation of hemoglobin, or as derivatives of protoplasmic substances originally colorless, brought forth by metabolic cellular activity. Neneky found a certain likeness between the minute composition of proteid chromogen which is obtained as the product of albumin in the pancreatic digestion and the composition of animal pigments. Neneky thinks, therefore, that in albumin there is contained a chromogen group which serves as the mother for the formation of blood and other pigments. After referring to chemical experiments with choroids of the eyes of oxen, he considers it possible to affirm that in such choroids there is a ferment more or less of the nature of tyrosin; that this is the first time, as far as he knows, that the presence of a ferment of this kind has been demonstrated in any normally pigmented organ in mammiferous animals, and that this fact renders it still more probable that natural melanins have their origin in the products of the albuminoid elements of cellular protoplasm and are occasioned by ferments of the type of tyrosin.

Tyrrel, Frederick. A famous London surgeon and ophthalmologist. Born in 1797, a nephew of Sir Astley Cooper, he became in 1811 a pupil of this well known man. Later he married Sir Astley's niece. In 1819-20 he studied in Edinburgh. Returning to London, he was soon appointed surgeon at the St. Thomas' Hospital and at the London Infirmary for Diseases of the Eye. He was also professor of anatomy and surgery at the Royal College of Surgeons. His death occurred suddenly, May 23, 1843, in the 46th year of his age.

Tyrrel was a quiet, modest, very warm-hearted man, whom almost everybody loved. He is said to have had sharp eyes, but, otherwise, an impassive countenance. He was a brilliant operator, an eloquent teacher, a well-loved man.

Tyrrel's ophthalmic writings are as follows: 1. Observations on the Catarrhal and Catarrho-rheumatic Ophthalmia. (*Med. Quart. Rev.*, 1834.) 2. Amaurosis. (Costello, *Cyclop. of Surgery*, 1837.) 3. *A Practical Work on the Diseases of the Eye, and Their Treatment, Medically, Topically, and by Operation.* (2 vols., London, 1840.)—(T. H. S.)

Tyrrel, Drilling operation of. In an attempt to clear the media of exudates following *sympathetic ophthalmia* Tyrrel passed a needle through the cornea near its outer part. It was then made to penetrate the anterior capsule (taking care not to injure the iris) to the depth of one millimetre. The handle was then rotated so that the instrument would act as a drill. The operation may be repeated several times at intervals of a month.

U

Überreifer Staar. (G.) Over-ripe cataract.

Ueberpflanzung der Hornhaut. (G.) Transplantation of the cornea.

Ueberpfropfung. (G.) Skin-grafting.

Uebungsphantom. (G.) Mask for practising operations on the eye.

U-fibres, Meynert's. See p. 7679, Vol. X of this *Encyclopedia*.

Uthoff's sign. Nystagmus occurring in multiple cerebrospinal sclerosis.

Ulcer, Aspergillar. Mucotic ulcer of the cornea. See p. 3335, Vol. V of this *Encyclopedia*.

Ulcer, Atheromatous. See p. 3336, Vol. V of this *Encyclopedia*.

Ulcer, Atrophic. This form is found in *neuroparalytic keratitis*, (q. v.) and is characterized by a paucity of subjective and objective signs of inflammation. The ulcer appears in the central part of the cornea as a grayish depression with ill-defined edges.

Ulcer, Bacillus pyocyaneus. See **Bacteriology of the eye.**

Ulcer, Bullous. See p. 1328, Vol. II and 3337, Vol. V of this *Encyclopedia*.

Ulcer, Central, of the cornea. Round central ulcer, sometimes called the central, non-irritative ulcer, is indolent and stationary, often remaining for months. It is round, and is located over the pupil. Often it is clear at the bottom, but may show some infiltration. It is characterized by the absence of irritative symptoms. Vessels are commonly absent, and photophobia and lachrymation are not marked symptoms. Such ulcers occur in cases of chronic catarrhal conjunctivitis and in trachoma. They may remain superficial or may become deep and end in perforation or in the formation of a permanent scar. As regards treatment, any conjunctival disease present must receive appropriate attention. This, combined with the daily use of a 1-per cent. strength solution of boric acid, and the protection of the eyes by dark glasses, will suffice. Atropin is generally unnecessary in this form of ulcer.—(J. M. B.)

Ulcer, Chiseled, of the cornea. Crescentic ulcer (name conferred by Soelberg Wells) and also called "chiseled," or "ditch," ulcer, is one of the rarest and most intractable forms of corneal disease. It generally appears at the upper part of the cornea, beginning near the limbus and extending like a crescent. It is called "chiseled" because it looks as though the epithelium and substantia propria had been cut out with a chisel. Such an ulcer spreads rapidly, following the curve of the corneal margin. The sclera is not involved. There may be two or even three such ulcers in the same eye. In the early stage the crescentic ulcer is almost transparent. Pain, photophobia, lachrymation, and redness are marked symptoms. If unchecked the process leads to perforation of the cornea with prolapse of the iris. In the regressive stage such an ulcer becomes cloudy, or of a grayish-white color, vessels grow into it, and it fills with semi-opaque tissue. Iritis is a frequent complication. This type of ulcer is usually due to catarrhal conjunctivitis. In simple cases the treatment of the affected conjunctiva by solutions of silver nitrate or of argyrol will be required. Severe cases will need the galvanocautery locally, and tonics and stimulants internally.—(J. M. B.)

See, also, **Cornea, Ring ulcer of the**, p. 3440, Vol. V of this *Encyclopedia*.

Ulcer, Corneal. For the various and numerous *ulcers of the cornea*, see the **Cornea** captions beginning with p. 3331, Vol. V of this *Encyclopedia*; also some **Keratitis** headings. Only those **Ulcer** captions will be mentioned here that are not readily found elsewhere.

Ulcer, Corneal, Bacteriology of. See **Corneal ulcer, Bacteriology of.**
Ulcer, Creeping, of the cornea. See p. 3447, Vol. V of this *Encyclopedia*.

Ulcer, Ditch. See **Ulcer, Chiseled.**

Ulcère de Penjdé. ULCÈRE D'ORIENT. (F.) Aleppo boil. See p. 217, Vol. I of this *Encyclopedia*.

Ulcère pointillé. (F.) One of the small corneal ulcerations observed in keratitis.

Ulcer, Jacob's. A rodent ulcer which begins as a small pimple on the skin of the lid near the inner canthus or over the lachrymal bone. It is shallow, with a well-defined, indurated margin, and its progress is very slow. It may remain superficial, but it usually extends deeply. See p. 1381, Vol. II, and especially, p. 6695, Vol. IX, of this *Encyclopedia*.

Ulcer, Lagophthalmic. See p. 6992, Vol. IX of this *Encyclopedia*.

Ulcer, Malarial. See **Cornea, Dendritic ulcer of the,** p. 3346, Vol. V of this *Encyclopedia*; also under **Malaria.**

Ulcer, Neuroparalytic. See **Keratitis neuroparalytica,** p. 6783, Vol. IX of this *Encyclopedia*.

Ulcer of the cornea. See the captions beginning with **Cornea, Abscess of the,** p. 3331, Vol. V of this *Encyclopedia*; as well as many corresponding **Keratitis** headings in Vol. XI. Only those **Ulcer** headings will be entered here that cannot readily be found elsewhere in this *Encyclopedia*.

Ulcer of the eyelid. See **Eyelids, Ulcer of the,** p. 5028, Vol. VII of this *Encyclopedia*.

Ulcer, Phlyctenular. See p. 3433, Vol. V and p. 6798, Vol. IX of this *Encyclopedia*.

Ulcer, Rodent. MOOREN'S ULCER. See p. 3405, Vol. V of this *Encyclopedia*.

Nettleship (*Trans. Ophth. Society U.K.*, Vol. XXII, p. 103, 1902), pointed out from an analysis of a number of cases, that the disease occurs between the ages of 23 and 71 years, but is most common between 40 and 60 years, and affects both eyes in about a quarter of the cases.

Much discussion has arisen as to the pathology of the condition. J. B. Lawford (*Royal Lon. Oph. Hosp. Reports*, Vol. XII, p. 266, 1889) examined the first case.

The term *rodent ulcer* was probably given because of the peculiar downgrowths of the proliferating epithelium which are found at the edge of the ulcer trying to cover the necrosing cornea beneath, but in other respects, both pathologically and clinically, the ulceration does

not behave like this disease, and the idea has now been generally abandoned. Andrade (*Ann. di Ott.*, XXIX, 1900), put forward a *bacterial origin* as the cause of the disease. In a case he found a small motile bacillus grouped like the Morax-Axenfeld bacillus, growing in pairs and chains, and having similar staining properties. Confirmation of this bacillus as the cause of the disease is still wanting, and in three instances which were examined by the writer it had not been isolated. This also has been the experience of several other observers. The behavior of the ulcer and its pathological appearance do not favor the view of bacterial origin, and it is probable that this organism found by Andrade was merely a saprophyte growing in a necrosing tissue.

W. T. Lister (*Royal Lon. Ophthal. Hosp. Reports*, XV, p. 352, 1903) showed a *necrosis of the superficial layers of the substantia propria*, and round the necrosing tissue an exudation of leucocytes, chiefly of the mononuclear variety. This does not necessarily mean that the disease is of inflammatory origin, as the presence of the necrosing tissue with saprophytic micro-organisms growing in the necrosing tissue would be quite enough to account for the leucocytosis.

Under the title *chronic serpiginous ulceration of the cornea*, Stephen Mayou (*Ophthalmoscope*, p. 438, Sept., 1915) remarks that this disease was recognized as early as 1849 by Bowman, although first described as a clinical entity by Mooren in 1867. It is a chronic ulcer with a serpiginous outline which first makes its appearance at the corneal margin, (in three-fourths of the cases in the exposed area of the palpebral fissure), and, as a rule, in time, involves the whole of the cornea. The base of the ulcer is greyish in color; the spreading margin is deeply undermined, and has an overhanging edge of proliferating epithelium. There is no discharge and no ciliary injection, unless pyogenic organisms are present. As the disease spreads, the portion that has been involved heals, the epithelium growing over its surface. There is little or no tendency to the formation of new fibrous tissue, as after the healing of an ordinary corneal ulcer, so that when the ulcer has entirely healed, there is a loss of about half the thickness of the cornea. Cicatricial tissue not being present, the opacity which follows is comparatively slight, so that fair vision may be restored.

The writer reported an example of those rare cases in which the whole cornea had been involved and had healed, but had broken down again and started to ulcerate.

The specimen shown by Mayou was from a woman, aged 63 years, with the duration of a year-and-a-half, in which the whole cornea had been involved. There was a loss of quite half the thickness of the cornea, with the formation of no new fibrous tissue; the substantia

propria was covered with thickened epithelium which had spread from the conjunctiva. In one situation, at the limbus, the whole process had commenced again; a small ulcer had formed, and was breaking down, involving about half the thickness of the remaining substantia propria. For this reason and on account of the pain the eye was removed.

The character of the necrosis and the fact that it nearly always involves the whole cornea and never perforates, together with the absence of the signs of inflammation when free from pyogenic organisms, and the fact that there is little or no attempt at the formation of fibrous tissue to replace the loss of the substantia propria made the author think that the condition was due to a necrotic process of the superficial layers of the substantia propria of the cornea as a result of defective nutrition. This was further borne out by the fact that the ulcer in three-fourths of the cases occurs in the portion exposed in the palpebral fissure; and Hillemanns (*Arch. f. Augenheilk.*, XL, 1899) has shown that the anterior ciliary vessels, which supply the nutrition to this layer of the cornea, manifest signs of degeneration and contain hyaline thrombi.

The *treatment of the condition* is, as a rule, highly unsatisfactory. Mayou wishes, however, to record one case in which a cure resulted without the cornea being completely involved and which had remained well for two years.—Miss W., aged 39 years, came on November 29th, 1912, with a typical Mooren's ulcer occupying about one-fifth of the cornea upwards and inwards in the right eye. The eye was free from all discharge, and showed practically no ciliary injection, the ulcer having a grey base with one or two vessels passing under it and a typical undermined spreading edge. The ulcer was examined for micro-organisms but nothing was found beyond one or two colonies of staphylococcus albus. The patient was treated for a month by pure carbolic acid and the actual cautery, with little or no effect. She was a thin, anemic woman and had pyorrhea alveolaris badly and all her teeth were removed. At the beginning of January a paracentesis of the anterior chamber was performed upwards and inwards, and the aqueous was evacuated daily with an iris spatula. This was continued for three weeks, and the wound was then allowed to heal. The ulcer showed distinct signs of flattening of the active margin and the epithelium was spreading over from the conjunctival surface. In March a similar paracentesis was again performed, and the wound kept open. By the beginning of May, the ulcer had completely healed. The patient's general health had very much improved since that date, and she had no further trouble with the eye.

Ulcer, Saemisch's. An infectious, spreading, ulcer of the cornea. See **Cornea, Serpent ulcer of the**, p. 3447, Vol. V of this *Encyclopaedia*.

Ulcer, Serpiginous. See **Cornea, Serpent ulcer of the**, p. 3447, Vol. V of this *Encyclopaedia*.

Ulcer, Variolar, of the cornea. See p. 3521, Vol. V of this *Encyclopaedia*. See, also, **Small-pox**.

Ulcer, Xerophthalmic, of the cornea. See **Keratomalacia**, p. 6829, Vol. IX of this *Encyclopaedia*.

Ulcus corneæ serpens. An ulcer beginning as such in the cornea and extending deeply into the corneal tissue. See p. 3447, Vol. V of this *Encyclopaedia*.

Ulcus durum. The indurated ulcer (chancre) of syphilis.

Ulcus rodens. See **Ulcer, Rodent**.

Ulcus serpens corneæ. See p. 3447, Vol. V of this *Encyclopaedia*.

Ulexin. See **Cytisin**, p. 3702, Vol. V of this *Encyclopaedia*.

Ullman, Christoph. A well known German anatomist, surgeon and ophthalmologist. Born at Cassell, Germany, May 11, 1773, he received his medical degree at Marburg in 1795, presenting as dissertation "Diss sistens Ossium Cariem." Settling in Marburg, he became in 1804 extraordinary, and, in 1807, ordinary, professor of anatomy; and, in 1805, ordinary professor of surgery. In 1839 he was made Privy Upper Medical Councillor. For a number of years he lectured on ophthalmology, and held ophthalmic clinics. His only ophthalmologic writing was "Ophthal. Beobachtung." (v. Ammon's *Zeitschrift f. Ophthalm.*, 1832). In 1843 he retired on account of ill health, and died at Marburg Jan. 18, 1849.—(T. H. S.)

Ulosis. (Obs.) Cicatrization.

Ultramicroscopic. Too small to be seen or resolved by the microscope.

Ultra-red rays. INFRA-RED RAYS. Those below or beyond the red of the spectrum. See **Infra-red rays**, p. 6197, Vol. VII; and **Spectrum**; as well **Illumination**; **Glaring**; and especially under **Heliotherapy**, and **Heat**; also **Light** rubrics beginning with p. 7471, Vol. X of this *Encyclopaedia*. As an application of ultra-red rays, see **Signals, Invisible**.

A. Vogt (Graefe's *Archiv. f. Ophthalm.*, pt. 1, Vol. 81; abst. in *Annals of Ophthalm.*, p. 556, July, 1912), after a number of experimental investigations regarding the permeability of the transparent ocular media for the ultra-red rays of artificial illuminants, concludes that: 1. The ocular media are penetrated by only such dark (ultra-red) rays which emanate from white, incandescent bodies. The dark rays emanating from red glowing bodies only partially penetrate the

media; those from bodies under red glow do not penetrate at all. 2. The ultra-red rays of electric light reach the retina in much larger numbers than the visible rays. 3. Only by very thick layers of water is it possible to absorb the ultra-red rays which penetrate the ocular media. For these rays the water is almost colorless. The dazzling experiments hitherto performed which intended injury of the lens or retina by visible rays need revision, for, according to the method of investigation of artificial illuminants, more ultra-red than visible rays reached the retina. The macular disturbances of solar rays result just as well from the numerous ultra-red rays which reach the retina. 4. Inasmuch as artificial illuminants, especially electric light, emit more heat rays and more heat rays which reach the lens and retina than natural light, the question arises whether certain external and internal ocular affections are not caused and furthered by such rays. 5. Of all rays the ultra-red rays play the most important rôle in the etiology of glass-blowers' cataract, for they reach the lens in greater numbers, are most numerous at the posterior axial portion of the lens where cataractous changes first appear, and are more easily absorbed by the lens than by the other ocular media. 6. His experiments show that Bruecke's and Helmholtz's conception regarding the ultra-red and red boundaries as the limit of perception to coincide with the limit of diathermancy is no longer tenable.

In part criticism of Vogt's methods and conclusions, Reichen (*Zeitschr für Augenheilk.*, Jan., 1914) remarks that Hertel proved that water allows rays of $2000\ \mu$ wave length to pass partially. Vogt succeeded in causing severe conjunctivitis in rabbits by exposing their eyes to rays of this wave length. The author isolated the ultra-red rays by using a prism of common salt, or alternately absorbed the rays by an opaque solution of iodine in carbon bisulphide, and then passing them through water and concentrating them with a lens of common salt. The source of light was a flaming arc. The rabbits were narcotized by the subcutaneous injection of ether.

Reichen found that ultra-red rays cause an irritation of the iris, indicated by contraction of the pupil which lasted some hours. The conjunctiva showed only slight signs of irritation. No changes were seen in the lens or retina.

Ultra-violet rays. INVISIBLE RAYS OF LIGHT. CHEMICAL RAYS. Those scarcely visible rays of the spectrum which are beyond the violet rays. See **Ultra-red rays** and the references therewith, especially under **Spectrum** and **Light**.

The deleterious action on the eyes of excessive exposure to ultra-

violet rays has been discussed under numerous headings in this *Encyclopedia*. See, e. g., p. 5390, Vol. VII, and p. 6160, Vol. VIII; also under **Colored glasses**, p. 2389, Vol. IV.

Strobl (*Klin. Ther. Wochenschr.*, Vol. X, No. 45) was among the first to point out the injurious effect of ultra-violet rays on the eyesight, and believed it possible that they might induce a circumscribed retinitis. See **Retinitis, Solar**.

A review of this subject in the *Ophthalmic Year-Book* for 1909 includes the investigations of Birch-Hirschfeld who has reported on the *injurious effects of the ultra-violet rays*, and described 5 cases in which the retinal disturbance caused scotomas for red and green, in addition to some conjunctival irritation. The patients, young men, had been working by the "Hareus" and "uviol" electric arc lights, without any adequate protection. They all recovered after several weeks or months. These are lights particularly rich in ultra-violet rays, and it is now pretty well established that these rays if powerful, and their action prolonged can cause serious injury to the eye. Stockhausen finds that in daylight the greater part of the ultra-violet rays are absorbed in the atmosphere; but they occur in larger proportion in light reflected from the surface of water, snow, etc.

The more modern, powerful, and economically produced artificial lights are all especially rich in ultra-violet rays. Schanz and Stockhausen have studied this point by photography, and published representations of the effects produced from different parts of the spectrum. The old oil lamps, candles and gas flames gave practically no ultra-violet rays, the photochemic effect ending with the visible spectrum. A marked change was seen with the incandescent lights. Both the electric incandescent, and the mantle burners, whether gas, petroleum or alcohol were used in the latter, show a distinct extension of the spectrum into the ultra-violet. The acetylene flame gave a similar spectrum. So did the Nernst lamp with a globe, and without the globe a much longer ultra-violet spectrum. But with the electric arc lamps of different forms the ultra-violet spectrum extended far out into the shorter wave lengths, and became much longer than the visible spectrum. In light from these sources, too, the maximum intensity was no longer found near the center of the visible spectrum, but near the violet end, and finally, in the mercury vapor lamp, the light was shown to consist principally in the two brilliant bands in the blue-violet, with which is combined an ultra-violet spectrum five times as long. Bourgeois states that the ultra-violet rays, the injurious ones, are found in ascending order in the following illuminants: petroleum, gas, incandescent electric, and acetylene.

The abundance of ultra-violet rays accompanying the light furnished by these artificial sources, and the harm these rays are shown to be capable of doing, give importance to means for protection against them. Most of the glass in common use cuts off the extreme—the short wave—ultra-violet rays. Schanz and Stockhausen in their experiments had to employ quartz prisms and lenses. The ultra-violet spectrum obtained through a glass globe was shorter than that obtained from the same source without a globe, but most kinds of glass in common use give very little protection from the ultra-violet rays nearest the visible spectrum. Blue glass and lighter shades of smoke glass permitted such rays to pass quite freely. Only the very dark smoke glass (No. 8) seemed to exclude them.

A yellow-green glass introduced by Fieuzal in 1880 seems to give fairly complete protection from all ultra-violet rays. A modification of this, “chlorphyll” glass, is put forward by Jacquemin for protective glasses. The yellow or amber glass, advocated by Motais, also excludes nearly all of the ultra-violet rays. Dye has pointed out its advantages shown in practical use under the tropical sun of Egypt, while Clere finds it equally serviceable in the strong light of high altitudes and snow. Schanz and Stockhausen, while giving no information as to its composition, urge the value of what they call “euphos” glass (q. v.). It, too, has light yellow-green color, from which we may suspect it is founded upon the work of Fieuzal. In the ordinary thickness for spectacles it is almost colorless, but gives efficient protection. Vogt, who also brings together much evidence of the harmful effect of ultra-violet rays, has found in a slightly yellow glass containing much lead a satisfactory protection against these dangers. The glass is put upon the market as “schwerflint.” Vogt suggests its use for shades and chimneys, for all sources of artificial light rich in the ultra-violet rays. Bourgeois recommends an orange-yellow glass for this purpose. For protection against the visible rays in partial cataract, corneal disease, mydriasis, etc., the smoked glass is preferable.

Vogt (*Archiv f. Augenheilk*, p. 161, 1908) pointed out how, in high concentration, the ultra-violet rays in our modern illuminants are deleterious to the healthy eye, producing conjunctivitis, keratitis, iritis, opacities of the lens and chorio-retinitis, and influence existing diseases of the eye unfavorably. He discussed the question by what means this deleterious effect of glaring sources of light may be prevented. An ideal protecting glass must fulfill two conditions: 1, Ability, in the usual thickness, to absorb all, or at least the greatest portion, of ultra-violet rays; 2, Lack of color.

The grayish-yellow glass of Fieuzal proved very useful as material for protective cataract spectacles. Its disadvantages consist in diminishing or abolishing the faculty to discriminate between colors and in the conspicuousness of its color. As the admixture of lead in the chemical composition of a glass has been found to increase the power of absorption of ultra-violet rays, Vogt succeeded in producing such a glass. This "schwerflint 0.198," in thin panes (1 to 2 mm. thick), is almost colorless, in panes 10 mm. thick it is slightly yellow. It absorbs in the thickness of the ordinary lenses (1 to 3 mm.) all ultra-violet rays to a small fraction, and transmits all visible rays except a small fraction of violet and blue.

Vogt points out that his glass can not supplant smoked spectacles in diseases of the cornea, iris, etc., with considerable photophobia, as this diminishes the intensity of all kinds of rays. The schwerflint, however, will prove of great service as material for lamps, to guard the eye against the glaring of electric, Welsbach, acetylene lights, etc., especially in factories, schools and sick rooms, without diminishing the intensity of light.

Spectacles of schwerflint are also recommended in incipient senile cataract or disposition to it, aphakia, conjunctivitis and keratitis, especially if caused by ultra-violet rays, chorio-retinitis of the macula and other ocular affections which may be produced by ultra-violet rays, also as a handy colorless protective glass in mountain tours, against diseases caused by certain vocations, e. g., the cataract of glass-blowers, blacksmiths and founders, and against electric ophthalmia.

Schanz and Stockhausen (*Popular Science Monthly*, Oct. 24, 1908) have shown that ophthalmia electrica is due to ultra-violet rays. The same disease, though in a less characteristic form, is produced also by many other illuminants containing a large percentage of ultra-violet rays. Snow-blindness is similar in its symptoms to electrical ophthalmia, and is likewise produced by ultra-violet rays contained in reflected sunlight. That the action of ultra-violet rays, so far from being confined to the external eye, also affects its deeper parts, is evidenced by the intense fluorescence of the lens which they are able to produce. As a slight turbidity is produced in the lens by an intense lighting with ultra-violet rays, it may be said that the cataract of old age is possibly due to a progressive alteration of the lens. The spectrum of crude oil lamps and candles hardly exceeds the region of visible rays. The ultra-violet rays, however, extend as soon as a chimney is added and an even more extensive spectrum is produced by using an incandescant mantle; but the longest ultra-violet spectra are found in electric illuminants. In all electric lamps fitted with a

glass cover of any kind, the short lengths are absorbed by the glass. Protective spectacles afford no protection against ultra-violet rays, and weaken the whole spectrum, for which reason they are not suitable for practical purposes. The authors have undertaken the production of a new kind of protective glass which is placed on the market under the name of "euphos." This glass, the writers state, is of a light greenish-yellow hue, owing its remarkable power of absorbing ultra-violet rays to its special composition rather than to its color. The composition can be adapted to each kind of lamp. With a very slight loss of light (3 to 5 per cent.) this glass screens off entirely any ultra-violet rays. Special experiments made on animals show that it really affords an efficient protection to the eye.

An attempt to demonstrate the protection of the normal crystalline lens against the harmful effect of ultra-violet light has been made by W. E. Burge and A. J. Neil (*Archives Ophth.*, Sept., 1915). They describe a series of experiments carried out to determine whether opacity of the lens or cataract could be produced in excised pig and ox lenses by radiant energy. The authors' method of conducting the experiments and their conclusions are: 1. Cataract or opacity of excised pig and ox lenses can not be produced by means of radiant energy from the infra-red, the visible, or the ultra-violet regions of the spectrum, under conditions much more extreme than any to which the human eye is ever subjected, provided the heat effect be excluded.

2. The lens protein can be so modified by weak solutions of the salts that are found in cataractous lenses and by dextrose that ultra-violet radiation can produce coagulation and hence opacity of the lens or cataract. 3. The same substances which modify the lens protein so that ultra-violet radiation can produce opacity also decrease the fluorescence of the lens. 4. Fluorescing bacteria are more resistant to the action of ultra-violet radiation than non-fluorescing. 5. A provisional hypothesis is advanced that the great resistance exhibited by the lens and by fluorescing bacteria to the action of ultra-violet may be due to this power of fluorescing. The assumption is that the lens and fluorescing bacteria by converting the absorbed short waves into longer waves get rid of more or less of the energy which otherwise would have been spent in coagulating their protein.

The Editor of this *Encyclopedia* has pointed out (*Prac. Med. Series*, 1916) that it is a serious question whether the foregoing series of experiments, as well as the vast majority of others conducted by means of such animal eyes as those of the pig, ox, rabbit, guinea-pig, etc., are of much or any value so far as deductions therefrom are drawn as to human eyes. Not only are the ocular tissues of the lower animals so different from those of man but the visual mechanism is entirely unlike

the human ocular apparatus. If they are to have any real value comparisons should always be made with eyes of the higher monkeys.

Traugott (*Münch. Med. Wochenschr.*, March 19, 1920: abst. *Journ. Am. Med. Assocn.*, June 19, 1920) states, as the result of his investigation, that ultra-violet rays do not affect the number of red blood corpuscles in man. Under normal conditions the same number of leukocytes are found in the capillary blood and in the venous blood stream. A uniform increase in the leukocytes takes place usually following raying with ultra-violet rays providing the sitting is continued long enough (from ten to fifteen minutes); if the exposure is of shorter duration, there will be a difference between the number of leukocytes in the capillary and in the venous blood. The increase caused by the raying affects leukocytes and lymphocytes alike. Another effect on the blood from the influence of the ultra-violet rays is that it coagulates sooner. The number of blood platelets is likewise increased.

Ultravisible organisms. Organisms invisible even by the aid of high power lenses. For instance, Zur Nedden (*Archiv. f. Ophthalm.*, Vol. 62, 1906) says that the organisms in sympathetic ophthalmia are ultravisible by present methods but are too large to pass through a Berkefeld filter.

Ultrazeozon. A trade name for a derivative of *esculin* (from the horse chestnut) employed for staining the cornea. See **Aqua zeozoni**.

Umbilication of the lens. O. Becker first described the condition and Pechin proposed the name. It is a very rare congenital anomaly, the opposite of *lenticonus* (*q. v.*).

Umbra. The shadow of an opaque body. See **Penumbra**.

Umbra glass. One of the numerous tinted varieties for protective lenses, put on the market by Zeiss, of Jena.

Umbraculum. *CORPORA NIGRA*. "Soot-balls"; seen in hooved animals especially, as black, spongy, pediculated portions of the uvea that pass through the pupil into the anterior chamber of the eye, probably as a protection against too strong light. See **Comparative ophthalmology**.

Umbral. Pertaining to a shadow.

Umbrascopy. A little used synonym of skiascopy or retinoscopy.

Umbrella injuries of the eye. These are so distinctive as almost to be placed in a class by themselves. A. Bouchart (*Recueil d'Ophthalm.*, Feb., 1911), has recorded three typical cases, as follows:

Case 1. A man, aged 20, struck on the supero-external part of the left orbit by an umbrella. Probe demonstrates a wound $6\frac{1}{2}$ cm. deep, with much edema round it, and impairment of ocular movements. The patient had had headache and signs of cerebral irritation, increased

temperature, and some suspicion of tetanus. All gradually disappeared, but three to eight weeks after the accident, the optic disc was pale, although vision was practically normal. Eighteen months later, the sight was quite normal.

Case 2. After injury of the upper-inner angle of the orbit with the ferrule of an umbrella, a small wound was associated with complete loss of sight and ocular movements on the injured side. Two weeks later, some signs of pallor of the disc, and return of ocular movements. At the end of six months, $V.=8/10$; slight ptosis and pallor of disc persist.

Case 3. Umbrella injury of supero-external angle of orbit. Two wounds, slight edema, tenderness over pulley of superior oblique, $V.=1/2$. Vision recovered, but at the end of three months there was some diplopia from paresis of the oblique.

The pallor of the disc and the paralysis of the recti are ascribed to the pressure of edematous and cicatricial tissues on the vessels and nerves supplying these structures, as no question of fracture of the optic canal or direct injury of the muscle could be raised. See, also, **Injuries of the orbit**, p. 9123, Vol. XII of this *Encyclopedia*.

Ume, Dr. The first teacher of ophthalmology as a separate branch of instruction in Japan. He returned to Japan from his European studies in 1884, and was at once appointed to the chair of ophthalmology in the Imperial Japanese University at Tokyo. According to one who knew him intimately, he was a good mathematician and refractionist but a poor operator. He was a large, strong man, with a red complexion, "who devoted himself to wine as well as ophthalmology." He died suddenly of pneumonia in 1886. He was succeeded in the chair of ophthalmology by Komoto, the present well-known incumbent.—(T. H. S.)

Umkehrung. (G.) Inversion.

Umore acqueo. (It.) Aqueous humor.

Umstülpung der Augenlider. (G.) Ectropion.

Uncinaria americana. Hookworm.

Uncinariasis. ANKYLOSTOMIASIS. HOOKWORM DISEASE. This subject has been largely described, and its eye signs discussed under several captions of this *Encyclopedia*. See the referenees under **Tunnel anemia**; and the section on p. 487, Vol. I. More recently a number of essays have been written on this subject; essentials of the chief of these being the following:

F. Phinizy Calhoun (*Journ. Am. Med. Assocn.*, p. 1075, Sept. 21, 1912) believes that this disease is responsible for *cataract* in certain instances and reports a number of cases in evidence.

J. W. Jervcy (*Journ. Am. Med. Assocn.*, p. 151, July 11, 1914)

reports on the *influence of hookworm on the eye* in a study of fifty-three cases. He saw two cases (4 per cent.) of *retinal involvement*. Four cases (7.5 per cent.) of folliculosis.

In the fifty-three cases there were thirty-five males and eighteen females. The ages ranged from 9 to 22 years. The diagnosis of hookworm was made microscopically in every case. Only one patient had been treated previously. Homatropin mydriasis was used in every case for retinoscopy and ophthalmoscopy. Patients, on the whole, responded to the mydriatic more quickly than normal persons. Refractive errors were found to follow closely the well-known average of persons of like age. There were two cases of interstitial keratitis. There were no marked eye-symptoms voluntarily referred to by a single patient. In twenty-six of these cases (approximately 50 per cent.) there was shallowness of the anterior chamber. The *most common fundus changes were pallor and tortuous vessels*, the latter occurring in twelve cases (22.6 per cent.). Retinal hemorrhage had occurred in two cases, and then in but slight degree.

Jervoy draws the following conclusions: The qualitative and quantitative *anemia* of hookworm disease is the general systemic condition for which it is responsible in this indirect way, and in this way is a causative factor in the various eye-lesions which have been described as accompanying it.

None of the eye-lesions occurring in this disease is in any sense sufficiently distinctive or characteristic to be of diagnostic value.

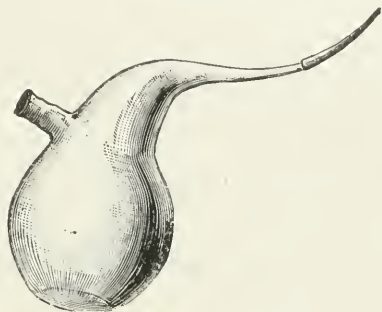
The evidence, collected from various sources, seems complete enough, and in addition if, in a systematic examination of the eyes of fifty-three consecutive and unselected cases, we find nothing to point us to a specific causative factor for the eye-lesions, and nothing in the clinical ocular pathology that could be regarded as a distinctive diagnostic aid in the recognition of the systemic disease, we may safely conclude that, in the light of our present knowledge, the *association of eye-symptoms and uncinariasis is purely incidental*, or at least that the eye-symptoms occur only as the sequelæ of general pathologic conditions, the principles of whose existence have long been recognized.

The writer points out that healthy and even athletic young persons from the rural districts are immune to the disease. Especially is this true of the negro. Though Burdell has shown that in certain localities in the South 65 per cent. of all negroes are infected with the parasite, and, while acting as intermediary hosts and active carriers of the disease, present no clinical symptoms whatever.

Obviously, it is well to know, when we see the signs of anemia in the eye-grounds, or in the facies for that matter, that we might properly

suspect the hookworm of being a possible cause of the anemia; but beyond this our studies of the coincidental eye-lesions in uncinariasis have not yet carried us.

Treatment of uncinariasis.—In a series of 126 cases thymol was given by Bercovitz (*China Med. Journ.*, Jan., 1919; abst. *Journ. Am. Med. Assocn.*, July 9, 1919) in hard gelatin capsules, 30 grains each of thymol and sodium bicarbonate being administered in two doses, one hour apart, followed by an ounce of magnesium sulphate one hour after the last dose. Chenopodium was given in hot coffee, or simple syrup; from 20 to 36 drops, according to the weight of the patient, administered in two doses, one hour apart, followed by an ounce of magnesium sulphate one hour after the last dose. There is over 40



Wicherkiewicz's Undine.

per cent. difference between the two drugs in favor of chenopodium in the case of the girls; and about 20 per cent. difference in favor of chenopodium in the case of the boys, with a difference of over 25 per cent. in favor of chenopodium if all cases are grouped together. It is also a safer drug than thymol, and it is easy of administration, being economical in time, as well as more pleasant to the patient. In addition, oil of chenopodium is effective as a vermifuge for *Ascaris lumbricoides*, and thus two infections are cured by one remedy. One point must be noted against chenopodium. At least ten days or two weeks should elapse before a reexamination of the feces is made.

Under-corrected. A term applied to lenses in which the marginal rays are focused before the axial rays; also said of glasses in human refraction that do not fully neutralize the ametropia.

Under-tint. A subdued tint.

Undines. See **Irrigation of the eye**, p. 6674, Vol. IX and the illustration on p. 169, Vol. I of this *Encyclopedia*.

The undine of Wicherkiewicz is depicted in this text.

Undulate. Wavy, having a waved surface.

Undulatory theory. The theory that light consists of a kind of undulatory motion, produced by the luminous body in the luminiferous ether, which is supposed to pervade all space. See p. 7471, Vol. X of this *Encyclopedia*.

Undurchsichtig. (G.) Opaque.

Ungekreutze Fasern. (G.) Those fibres in the optic chiasm which do not cross to the opposite side.

Unger, Karl. A well known German surgeon, of some importance in ophthalmology. Born at Lissa in 1782, he studied at Leipsic and Halle, at the latter institution receiving his medical degree. In 1810 he became assistant at Hufeland's University Hospital in Berlin, in 1813-14 served in the army in a medico-chirurgical capacity, and in 1815 became professor of surgery and ophthalmology in the Albertus University at Königsberg. In 1829 he received a dissection wound, from which he never wholly recovered, though he did not die until Mar. 28, 1835.

Aside from works of a general medical or surgical character, he wrote *Nachricht über das Arztl.-Wundärztl. und Augenheilkund. Klinikum der Königl. Universität Zu Königsberg* (Königsb., 1823).—(T. H. S.)

Unguenta. UNGUENTS. See **Ointments**, p. 8476, Vol. XI of this *Encyclopedia*.

Unguentum adipis. See **Unguentum simplex**.

Unguentum aquæ rosæ. See **Cold cream**, p. 2319, Vol. IV of this *Encyclopedia*.

Unguentum cereum. See **Unguentum simplex**.

Unguentum Credè. A proprietary ointment of colloidal silver. See **Argentum colloidal**, p. 564, Vol. I of this *Encyclopedia*.

Unguentum diachylon, U. S. See **Diachylon ointment**, p. 3934, Vol. V of this *Encyclopedia*.

Unguentum emolliens. See **Cold cream**.

Unguentum glycerini. See **Glycerite of starch**.

Unguentum hydrargyri. See **Mercurial ointment**, p. 7646, Vol. X of this *Encyclopedia*.

Unguentum hydrargyri cinereum. See **Unguentum hydradgyri dilutum**.

Unguentum hydrargyri dilutum. BLUE OINTMENT. UNGUENTUM HYDRARGYRI CINEREUM. Mercurial salve, the so-called *blue ointment*, is often used alone or in conjunction with other agents as an application to the external eye. Its action is chiefly that of counter-irritant and derivative, and as such is occasionally used in scleritis, phlyctenules, etc. It is one of the ingredients of the popular Arlt's forehead ointment.

Unguentum hydrargyri nitratis. See **Citrine ointment**, p. 2284, Vol. III of this *Encyclopaedia*.

Unguentum iodi Rademacheri. An ointment made by moistening 1 part of iodine with a little absolute alcohol, reducing to a very finely triturated condition, and mixing with 20 parts of hog's lard. It contains nearly 5 per cent. of iodine.

Unguentum leniente. See **Unguentum rosatum**.

Unguentum oculare Kliseri. An ointment of 8 parts of verdigris, 150 of tartar, 40 of camphor, and 620 of lard.

Unguentum ophthalmicum. (1) In the *Swiss Ph.*, an ointment of 10 parts each of calomel, zinc oxide, and white bole and 50 of lard. (2) An ointment of two parts of red mercury oxide, 38 of yellow wax, and 60 of almond oil (3) or of two parts of yellow mercury oxide and 98 of unguentum cetacei.

Some of the older pharmacopeias directed it to be made of zinc sulphate mixed with 6 or 7 times as much fresh butter.

Unguentum ophthalmicum album. Unguentum zinci oxidi. Zinc ointment.

Unguentum ophthalmicum compositum. An ointment made (*Ger. Ph.*) of 15 parts of red mercury oxide, 5 of camphor, and 10 of almond-oil; or with 30 of yellow wax, 210 of lard, $7\frac{1}{2}$ each of zinc oxide and olive-oil, and 4 of camphor (*Swiss Ph.*).

Unguentum ophthalmicum lausannense. (*Swiss Ph.*) An ointment of two parts of red mercury oxide, 120 of lard, 8 of tinctura opii crocata, and 12 of solution of subacetate of lead.

Unguentum ophthalmicum richteri. An ointment of 2 parts of red precipitate and 6 of cacao butter and lard.

Unguentum ophthalmicum rubrum. Unguentum hydrargyri oxidi rubri.

Unguentum paraffini. A simple, emolient unguent used as a base for salves or to be mixed with other ointments. It resembles our petrolatum (q. v.).

Unguentum rosatum. UNGUENTUM LENIENTE. COLD CREAM. See p. 2319, Vol. IV of this *Encyclopaedia*. In addition there is also this salve for *scabies ciliarum*: Sulphur depurati, 1.0 (gr. xv); Camphoræ, 0.6 (gr. ix); Olei olivæ; Unguenti rosati, āā 15.0 (5iij ss).

Unguentum simplex. UNGUENTUM, U. S. UNGUENTUM ADIPIS. UNGUENTUM CEREUM. SIMPLE OINTMENT. This salve, generally used as a basis for other ointments, is made by gently heating together 1 part of white wax and 4 parts of benzoated lard.

Unguentum, U. S. See **Unguentum simplex**.

Unguipressio. Pressure with the thumb nail for the rupture and expression of trachoma (q. v.) follicles.

Unguis. (It. and L.) A nail. A synonym of *onyx*, p. 3331, Vol. V of this *Encyclopaedia*.

Uni-bifocal. A trade name given to "one-piece," "invisible" bifocal lenses.

Unilateral hallucination. An hallucination that is perceived by one visual or one auditory centre only.

Uniocular. MONOCULAR. See **One-eyed**, p. 8483, Vol. XI of this *Encyclopaedia*.

Uniocular diplopia. Double sight with one eye. It occurs in commencing cataract, in irregular cornea, and occasionally in cases of cerebral tumor.

Unit, Angström. The measurement and mapping of the solar spectrum was carried out by A. J. Angström, who measured an extremely large number of the lines and made a map of the spectrum. This map was called by Angström the Normal Solar Spectrum and was published in 1868. This great research was carried out with the aid of three gratings ruled on glass by Nobert. These measurements covered the region A to H, *i. e.*, all the visible spectrum, and the wavelengths were expressed in ten-millionths of a millimeter. This unit of length has been used ever since in wavelength determination under the name of *Angström Unit*. The same unit of length, the ten-millionth of a millimeter, equals 1×10^{-10} meter and is often called, as suggested by Johnstone Stoney, a tenth-meter. Frequently also wavelengths are expressed in thousandths of a millimeter (μ) or millionths of a millimeter ($\mu\mu$). The wavelength of the D_1 (sodium) line may be expressed as $0.589616\mu = 589.616\mu\mu = 5896.616$ A. U. or t. m. The abbreviation for Angström Unit is A. U. and for the tenth-meter is t. m.—(C. S.).

United States, Laws of, Relating to ophthalmology. See (*supra*), **Ophthalmology, Legal relations of.**

Units of direction. A term used by Fraser (*Oph. Year-Book*, p. 40, 1909) who publishes a visual illusion in which lines of the figure are made up of parts termed "units of direction." These run oblique to the general direction of the line, like the strands on a twisted cord. This is placed upon a checker-work background, and the effect is that the lines seem to run not in their true course, but more in that of the units of direction.

Universal drops. This name was given to a collyrium instilled into the eyes of army laborers (Chinese especially) at the battle front and was ordered by Colonel W. T. Lister, R. A. M. C., for the purpose of

relieving the dust conjunctivitis (or for preventing other serious infections of the conjunctiva) so common among these men. It consisted of a solution of sulphate of zinc (0.3 per cent.) and boric acid.

See **Trachoma**.

Unlearnable test types. See **Test chart**; also p. 4645, Vol. VI of this *Encyclopedia*.

Unreifer Staar. (G.) Immature cataract.

Unripe cataract. An immature cataract; one not yet fit for operation.

Untersuchung. (G.) Examination, investigation.

Unverricht's disease. THOMSEN'S DISEASE. Myotonia congenita. See p. 8277, Vol. XI of this *Encyclopedia*.

Upright image. An enlarged (or direct) image of the fundus, seen with the ophthalmoscope without the interposition of a bi-convex lens.

Upright vision. ERECT IMAGE. The paradox that we actually see things right side up, although our eyes are constructed to see them upside down, has never been satisfactorily explained. Anatomical reasons are sometimes given, says Gradenwitz (*Scientific American*, June 9, 1906). It is suggested that the optic nerves, which transmit the visual impression to the brain, cross each other, and that the inverted image of the retina will, therefore, be seen vertically. It seems that in all these explanations the theorist confuses the subjective visual impression and the merely objective optical phenomenon, viz., the production of an image on the retina.

That upright vision is quite independent of the position of the image on the retina may be inferred from the fact that on inclining the head we still see objects in their proper positions, although the positions of the images on the retina are changed. The question naturally arises: By what standard, conscious or unconscious, does the eye judge in the gauging the upright position of things independently of the position of the head? Is there perhaps some organ which acts like a carpenter's plumb-line or spirit-level and indicates the direction of a given line?

Sir Hiram Maxim has given some thought to this problem. His views were seriously influenced by a chance observation. One day when he was tired from a long railway journey, he noticed, on looking at an incandescent lamp, and then closing his eyes, that a distinct image of the filament still remained, which is a well-known optical phenomenon. After turning his head to the right about 45 degrees still looking steadily at the lamp for about half a minute, he closed his eyes and placed his head in a vertical position. He then found that the image of the filament was inclined 45 degrees in the other direction. He now turned his head to the left, and

again looked steadily at the lamp. On closing his eyes and placing his head in a vertical position, he distinctly saw two images of the filament crossing each other at about 90 degrees. This proved, to his mind, that the position of the head and the angle of the image on the retina had nothing whatever to do with seeing things right side up. Not only this, but it showed at the same time that we judge the position of objects on the retina by comparing them with some organ which is a part of the mechanism of seeing, and which is controlled by the attraction of gravitation. See, also, **Inversion of vision**, p. 6560, Vol. IX of this *Encyclopedia*.

Uranin. URANIN YELLOW. See **Fluorescein**, p. 5229, Vol. VII of this *Encyclopedia*. It may also be noted here that C. Hamburger (*Klin. Monatsbl. f. Augenheilk.*, May, 1909), who has extensively employed uranin for the staining of human lesions, makes the following observations: Uranin is not poisonous. After a sufficient dose of an aqueous solution the skin and mucous membranes assume an icteric color. The secretions of the conjunctiva and nose are green; the urine dark-red. It has no detrimental influence on the course of intra-ocular inflammations or operations. Uranin does not involve healthy eyes at all (or after two to three hours in minimal quantities), but stains, within from 30 to 40 minutes, the aqueous of inflamed or injured eyes bright green, proportionally to the degree of inflammation. Conjunctival catarrh and slight erosions of the cornea are not sufficient; it must be an intra-ocular inflammation or irritation, propagated to, or emanating from, the iris or ciliary body. The experiment on living man—uranin given an hour before the operation—demonstrates that the iris chiefly participates in the regeneration of the aqueous, clearly confirming the contention of the author, propounded for many years, in direct opposition to Leber and his school.

The history of three patients (with tuberculous iritis, irido-cyclitis, and hypopion ulcer of the cornea), each having taken two hours previously 6 grams of uranin is given by Marzoratti (*Annals of Ophthal.*, July, 1911). General icterus and a greenish color of the aqueous humor were noted. The author recalled the experiments of Hamburger and Buerk and arrived at the same conclusions, that is to say, coloring of the media and fluorescence is indicative of an inflammatory process. These researches have been carried out in 35 cases, among which was one of sympathetic ophthalmia and two cases of traumatism with opacities of the vitreous body, and they all showed fluorescence of the vitreous.

Uranium. A very hard but moderately malleable metal, sp. gr. 18.7, resembling nickel or iron in its luster and color; but in a finely com-

minuted state occurring as a black powder. It is not oxidized by exposure to air or water at ordinary temperatures; but if heated in the air it burns brilliantly, and is converted into oxide. It is a comparatively rare metal, which never occurs native; its chief source being *pitchblende*, which contains from 40 to 90 per cent. of black oxide. The black oxide is used as a pigment for coloring porcelain. M. Becquerel's discovery of the Becquerel rays in 1896 showed that certain salts of uranium emitted a new kind of radiation, invisible to the eye, but capable, like the Röntgen rays, of traversing metals and other bodies opaque to ordinary light, and of impressing a photographic plate. It was soon suspected that the mysterious properties belonged not to the uranium, but to the new metals radium, polonium, and actinium.—(*Standard Encyclopedia*.)

Uranoscopy. Ocular observation of the heavenly bodies.

Urari. CURARE. See p. 3587, Vol. V of this *Encyclopedia*.

Uratic conjunctivitis. See p. 3036, Vol. IV of this *Encyclopedia*.

Urea hydrochlorid. This salt compounded with quinin to form a *quinin hydrochloro-carbamid* is a crystalline substance soluble in water. It is used in one per cent. solution hypodermically as a local anesthetic. It is also called *urea-quinin*.

Reber (*Oph. Year-Book*, p. 75, 1916) feels that no strabismus operation should be done except under local anesthesia. If ethyl hydrocuprein or quinin and urea hydrochlorid in 0.5 per cent. solutions are used, the patient will often have perfect comfort for eight or ten hours after.

Urea-quinin. See **Urea hydrochlorid**.

Uremic amaurosis. Blindness without demonstrable changes in the retina or optic nerve is a symptom in persons with *chronic nephritis*. It is more frequently found in the *acute nephritis* of *scarlatina*, *variola*, and *measles* and in the *nephritis of pregnancy*. It always involves both eyes and appears suddenly, the patient becoming suddenly blind and remaining in this condition for from eight to twenty-four hours. In most cases vision is completely lost, but in some instances perception of light exists during the attack.

Severe cerebral symptoms—such as headache, vomiting, epileptiform convulsions, and coma—are rarely absent. They may precede the blindness or they may follow it. During the attack the urine is generally lessened in amount; rarely diuresis has been observed. Some authors have recorded the absence of albumin from the urine during the attack, although it was to be found both before and after the seizure. Uremic amaurosis may be the first sign of renal disease and may be associated with deafness.

Although in the majority of cases of uremic amaurosis blindness of both eyes appears simultaneously, Leber has recorded a case in which first one eye became blind, and the next day vision was lost in the other.

During the attack the pupils are either widely dilated and immobile or they react to light in spite of the complete loss of vision. Schmidt-Rimpler considered the latter condition to be the rule, to which there are exceptions. The presence of the pupillary reaction is a favorable symptom, since it indicates that the optic nerve is normal and atrophy need not be feared.

Ophthalmoscopic examination generally shows no changes in the fundus, but, exceptionally, transient optic neuritis, dilation of the retinal veins, and slight retinal edema have been observed.

The prognosis of uremic amaurosis is favorable. The blindness rarely fails to disappear in from twelve to twenty-four hours, and full visual acuity is reached in two or three days. During recovery transient defects in the visual field are often observed. Repeated attacks may occur at intervals of weeks or months or during repeated pregnancies. Permanent blindness from uremic amaurosis has not been observed. Where vision is permanently lost, changes will be found in the retina or in the optic nerve.

The treatment must be directed to the general condition of the patient.—(J. M. B.) See, also, under the captions italicized above, especially under **Nephritis**, p. 8308, Vol. XI of this *Encyclopedia* as well as **Toxic amblyopia**.

Uridrosis. Urinous sweat is seen about the eyelids and always in connection with a generalized form of the diseases depending upon a general involvement of the system.

Urine. This has been a popular remedy in every land and age for diseases of the eye. Dioscorides recommends that the urine be boiled with honey or ethereal oil in a brass vessel. It is then especially good for corneal or palpebral ulcers and for corneal cicatrices. The urine of a boy who had not attained to the age of puberty was supposed to be the best sort. Now and then the patient was instructed to hold his eyes open over a vessel of urine, in order that the vapors of that substance might act upon the eyes.—(T. H. S.)

The infection and, occasionally, the loss of an eye from the employment of toxic urine for the popular treatment of eye affections is well known. See, in this connection, p. 3138, Vol. V of this *Encyclopedia*.

Urinometer. A hydrometer for testing the density of urine.

Urner's liquid. See **Acid, Dichloracetic**, p. 68, Vol. I of this *Encyclopedia*.

Urotropin. See **Hexamethylene-tetramin**, p. 5917, Vol. VIII of this *Encyclopedia*.

Urticaria of the lid. See **Hives of the lid**, p. 5010, Vol. VII of this *Encyclopedia*.

Urticaria gigantea. **ANGIONEUROTIC EDEMA.** Urticaria marked by large, soft swellings, chiefly about the face and eyes. Called, also, *urticaria edematosa*.

U-shaped lid clamp. Mark Stevenson's (*Ophth. Record*, February, 1913) first model was made several years ago, two years before Wilder described his very similar V-shaped lid clamp. For years he discontinued the use of this first instrument because the sharp edges of the metal cut into the lids, causing severe pain when it was sufficiently tightened to prevent hemorrhage. However, if proper sized rubber tubing, such as is used on the eye wires of spectacles, or a little larger, is pulled over the metal arms, the tissues are not cut and very little, sometimes no, pain is caused. In addition the pressure of the elastic rounding rubber surface serves better to constrict the blood vessels than the flat metal arms. The instrument is larger than the Wilder V-shaped one and shaped like the letter U, somewhat similar to one of the arms of the old models of lid clamps. Stevenson has also had the set screws made so that the pressure of the blades can be regulated from either side, permitting easy use of the instrument on either the upper or lower lids of either eye.

Ustioni della cornea. (It.) Cauterization of the cornea.

Utropin. Same as **Urotropin**.

Uvari. Curare.

Uvea. **UVEAL TRACT.** A name applied formerly to the posterior surface of the iris; in present use, the iris, ciliary body, and choroid considered together, forming the pigmentary layer of the eye. See **Uveal tract**.

Uvea, Ectopia of the. **ECTOPIUM UVEÆ.** See p. 4139, Vol. VI of this *Encyclopedia*.

Samuels (*Zeitschr. f. Augenheilk.*, April, 1914) has described the clinical features and microscopical anatomy of a case of congenital ectopia of the uvea. The subject died of tuberculosis.

Uveal. Pertaining to, or forming, the uvea.

Uveal tract. **UVEA.** See p. 382, Vol. I, as well as p. 5951, Vol. IX of this *Encyclopedia*.

Uveal tract, Diseases of the. **UVEITIS.** See, also, the various **Iritis** captions; as well as **Cyclitis** and **Choroiditis**.

An early but instructive discussion of *uveitis in general* took place before the Oph. Sec. Am. Med. Assocn., June, 1902. The papers on

and the discussion of the subject are printed in the *Journal* of that year.

Etiology in general of uveal tract diseases. See, in particular, **Iritis.**

L. Bach (*Zeitschr. f. Augenheilk.*, January, 1912) collected all cases of so-called *primary diseases of the uveal tract* observed during the previous 16 years, about 400, and had them re-examined as far as possible and Wassermann's test made. The tuberculous granulation tumors and the undoubtedly luetic affections were excluded.

Binocular affections of the choroid were four times as frequent as those of the iris. Tuberculosis and rheumatism were the most frequent etiologic factors, viz., tuberculosis with greatest probability in 15 per cent. of iritis and cyclitis, 20 per cent. of iridocyclitis, 18 per cent. of choroiditis, rheumatism in 18 per cent. of iritis against 7 per cent. of choroiditis. This corresponds with the experiences of Krückmann, who paid special attention to the etiology of diseases of the uveal tract.

Very often the history of the case and the most careful general examination revealed no clue as to the etiology, viz., in 47 per cent. of iritis and 59 per cent. of choroiditis. With reference to the experimental researches of Stock quite a number of such cases, if examined with modern methods, especially Röntgen rays, might have proven tuberculous. Seventy per cent. of iritis and only 40 per cent. of choroiditis were cured.

In the Ophthalm. Section of the International Medical Congress, London, 1913, there was a formal discussion on the *pathogenesis of chronic uveitis, excluding syphilitic, tuberculous and sympathetic cases.* The discussion was opened by Fuchs, who includes under the term "uveitis" iritis, iridocyclitis, and iridochoroiditis. By chronic he means cases which begin with little or no sign of inflammation and thus continue for years, or in which severe signs of inflammation only appear very late. The characteristic exudate in chronic uveitis is the deposit on the posterior surface of the cornea. The clinical picture corresponds to two different conditions to which Fuchs applies the terms true precipitates and pseudo-precipitates. By pseudo-precipitates he understands a continuous cellular layer of unequal thickness on the posterior surface of the cornea, such as is most frequently found in traumatic iritis. The true precipitates are circumscribed compact spherical cellular masses which enclose large nuclei. Usually either precipitate disappears without leaving any trace, but occasionally they are invaded by fibroblasts and become organized and permanent. The cells which compose them may arise from the iris, the anterior portion of the ciliary body, and possibly also from the posterior portion of

the ciliary body. Fuchs' cases are described in five groups, which are really only artificially classified gradations from the mildest to the most severe cases. There is a proliferation of the ciliary epithelium, which suggests that the poison acts on the surface of the ciliary body. It must therefore be present in the aqueous, which it can only reach through the blood-stream. In iridocyclitis from detachment of the retina it is quite clear that the poison is not microbic: it is probably due to the irritating influence of the subretinal fluid. But instead of the proliferation of the epithelium found in ordinary chronic uveitis, there is a formation of fibrous tissue.

On the same occasion de Schweinitz discussed the disease, especially in its biochemic aspects. In his opinion every case of uveitis is of septic or toxic origin. But he would discard the term "rheumatic iritis." Acute articular rheumatism is very rarely a cause of uveitis. Although persons suffering from so-called muscular rheumatism and chronic polyarthritis develop the disease; such cases are probably the results of autotoxemias and have nothing to do with rheumatism. In these cases not only the urine, but the whole metabolism should be studied. The absence of indican cannot be accepted as clear proof that intestinal autointoxication does not exist.

Lawford regarded as proven the dependence of some forms of mild chronic iridocyclitis on *pyorrhea alveolaris*, and also agreed that some forms of localized exudative choroiditis may result from the same affection. In a sense cataract may be due to intestinal toxemia through the production of chronic uveitis. He also thought it is not improbable that recurring vitreous hemorrhage in young men might be due to the consequences of intestinal stasis. Clarke expressed a similar opinion as to the cause of premature loss of accommodative power and of sclerosis of the lens, and had great faith in the administration of petroleum oil for the relief of the intestinal condition.

As opposed to the view of Fuchs and others that the deposits on Descemet's membrane are always derived from the uvea, Opin finds in a case carefully examined by him that the abundant precipitates formed during life were due exclusively to active proliferation of the cells of the endothelium of Descemet's membrane. Villard observed two cases of iridochoroiditis in young infants with severe gastro-enteritis, the first he believes on record. He thinks that enteritis was the cause of the uveal inflammation. Cramer observed a large number of instances of mild iridocyclitis follow endemic infectious intestinal catarrh. He believes the ocular affection to have been a metastasis.

Galezowski and Berehe report five cases of iridocyclitis which occurred soon after bilateral removal of the ovaries; the cases are analag-

ous to similar conditions known to occur in menstrual disturbances and the menopause; the favorable action of ovarian extract upon the progress of the cases also points to the causal connection with the operation. The extract checked the progress and brought about amelioration; relapse followed abandonment of the remedy. Two of the cases which were not treated by organotherapy ended in blindness. Grand-Clément again calls attention to the form of uvéitis which he terms "uvéite irienne" (q. v.), the quiet iritis of Hutchinson.

In Rubert's case of late traumatic uveitis histological examination showed proliferative and degenerative changes of greater extent than those usually found in similar cases. The uvea presented a marked proliferative inflammation, most developed at the posterior pole and possessing much in common with Fuchs' picture of sympathetic ophthalmia. Iron may cause proliferation of the epithelium of Descemet's membrane and may lead to connective tissue deposits upon the posterior surface of the cornea. Endothelial-like cells were found upon the inner surface of the retina, which in part were certainly derived from the unusual proliferation on the part of the pigmented epithelium. In the midst of the glia-like degenerated tissue were extensive formations of connective tissue masses in some regions, with complete degeneration of the same in others.

Lea employed salicylate of potash with excellent effect in an epidemic of cyclitis with constitutional symptoms which occurred in Kimberly, South Africa, principally among the Kaffirs in the compounds. The writer sees in this use of the drug a substantiation of Gifford's good effects from the same in sympathetic ophthalmia and inflammations of the uveal tract generally.

Charles Goulden (*Royal Lon. Ophthalm. Hosp. Reports*, Vol. XIX, part iii, November, 1914) in his investigation of 193 cases of *inflammation of the uveal tract*, occurring in 6,835 patients, divides them into: iritis, 37 cases; iridocyclitis, 142 cases; and choroiditis, 14 cases. The causes of the secondary affections reviewed by him are: (1) oral sepsis (a) dental, and (b) tonsillar; (2) gastro-intestinal sepsis (a) gastric, and (b) intestinal (small gut and large gut), with special headings for dysentery, appendicitis, etc.; (3) respiratory sepsis (a) nose and nasal sinus trouble, (b) adenoid and middle ear trouble, (c) lung trouble (further subdivided); (4) gonorrhea, and (5) uterine sepsis. The author concludes that many cases of uveitis are probably due to infection from a diseased mucous membrane. The most common cause is oral sepsis. In the cases of gonorrhea and typhoid fever he regards the connection between the eye trouble and its alleged causes as completely proved bacteriologically, whilst the indictment against

the pneumococcus is, in his opinion, scarcely less strongly supported. The dangers from gonorrhea cover many years, and make the disease appear a far more serious one than it is generally credited with being. The type of uveitis which consists of a solitary patch of exudation into the choroid, with vitreous opacities and keratitis punctata, he regards as being always secondary to a source of septic infection in some other part of the body, that source being usually a mucous membrane.

Max E. Maxwell (*Ophthalmoscope*, p. 456, Sept., 1916) on the *diagnosis of uveitis*, modifies the classification (exogenous and endogenous) of de Schweinitz as follows: *Endogenous infections* may be classified as due to certain groups of diseases. 1. Constitutional diseases or disorders of metabolism—as gout, rheumatism, diabetes. 2. Specific infectious diseases—as tuberculosis, syphilis, gonorrhea, influenza. 3. Blood diseases—as anemia. 4. Renal disorders and anomalies of urinary secretion—as nephritis, lipemia, oxaluria. 5. Auto-intoxications—as in intestinal disorders, menstrual disturbances, detachment of retina. 6. Local diseases and infections—as in the rhinopharynx, tonsils, teeth, accessory sinuses, skin, etc. 7. Sympathetic ophthalmia.

Treatment of uveitis. As will readily be seen by the foregoing the conduct of a case of uveitis will depend upon the cause of the disease and will be equally influenced by the part of the tract mostly involved. The reader is referred for this reason to the *treatment* rubrics under **Iritis; Choroiditis; Cyclitis; Sympathetic ophthalmia; Injuries of the eye**, etc., for guidance. In this connection also it will be well to refer to the headings **Sweat bath; Thyroid extract; Salicylic acid**, etc.

Uvéite irienne. Grand-Clement in 1891 called attention to the importance of distinguishing from ordinary iritis those cases in which only the posterior layer of the iris is involved. To these he applies the term *uvéite irienne*. In every respect this affection is different from ordinary iritis, and the points in differentiation are given in the following table:

Uvéite Irienne.	Iritis.
Occurs almost exclusively in women.	Occurs irrespective of sex.
Both eyes are always affected.	Often is unilateral.
Disease lasts for years and shows slight periodic exacerbations, lasting five or six days.	Symptoms are violent, and the disease is cured in six or eight weeks.
Causes are unknown.	Causes are trauma and constitutional vices.

Uvéite Irienne.	Iritis.
Only effective treatment is iridectomy.	Proper treatment is the use of mydriatics.
No discoloration of anterior surface of iris.	Anterior surface of iris is discolored.
Pain is almost absent and redness is slight.	Pain is severe and redness is marked.
Occurs about the time of the menopause.	(—J. M. B.)

Grand-Clement (*Lyon Médical*, p. 1347, June 23, 1912) has reported an additional example of the disease and repeated his belief in the entity of the affection.

Uveitis. UVEITIS IN GENERAL. See **Uveal tract, Diseases of the.**

Uveitis, Anterior. A synonym of *sclerokeratoiritis* (q. v.); sometimes the term is applied to *parenchymatous keratitis*.

Uveitis, Endogenous. See **Uveal tract, Diseases of the.**

Uveitis, Fibrinous. This is the form that occurs in grave cases of *sympathetic ophthalmia* (q. v.).

Uveitis maligna. One of the synonyms of *sympathetic ophthalmia*.

Uveitis serosa. See **Keratitis, Punctate**, p. 6805, Vol. IX of this *Encyclopedia*.

Uveitis, Suppurative. See p. 2145, Vol. III of this *Encyclopedia*.

Uveitis, Variolous. See **Smallpox**.

Uveo-parotid fever. Lehmann (*Oph. Year-Book*, p. 154, 1916) encountered two cases, and knows of ten others in Denmark, of febris uveoparotidea. It represents a definite *syndrome of bilateral uveitis*. It resembles cases of syphilitic origin in some respects but is absolutely neutral to specific treatment, with bilateral parotitis, low continuous fever and in half the cases, facial paralysis. The uveitis runs a chronic course and may eventuate in blindness in one or both eyes in the severer cases. In a few cases other glands besides the parotid were affected likewise. Schou, for example, who observed a few cases, mentions that the iridocyclitis may be accompanied by swelling of the parotids or other salivary glands, occasionally of the lachrymal and lymphatic glands. The glands are always affected symmetrically. The prodrome is protracted; the first symptom may be the facial paralysis, which may keep up for three or four weeks before the uveitis or parotitis develops. The latter resembles mumps to a certain extent; but its long persistence, the absence of any known source of infection, the absence of any contagion from these cases, and likewise the fact that orchitis was never known in any instance, seems to exclude epi-

demic parotitis. The parotitis may develop as an indolent tumor, persisting for two years. In all the cases, however, the parotid lesions and the facial paralysis entirely retrogressed in time. A number of points differentiate this affection from Mikulicz' disease (*q. v.*) of the lachrymal and salivary glands, as Lehmann describes in detail. In nine of the twelve patients there was nothing to suggest tuberculosis or a predisposition thereto, no traces of scrofula, and the skin and subcutaneous tuberculin tests applied to three elicited a negative response. The other three were undoubtedly tuberculous.

Uveo-scleritis. A synonym of deep scleritis (*q. v.*)

Uviol glass. One of the numerous colored protective glasses on the market. See **Colored glasses.**

V

V. An abbreviation for *vision* or *visual acuity*; also a symbol for vanadium.

Vaccination, Anti-smallpox. See **Vaccinia of the ocular structures.**

Vaccine, Antityphoid. For oculotoxic effects see, also, *Vaccine, Antityphoid*, under **Toxic amblyopia.**

Vaccines in ophthalmology. VACCINOTHERAPY. VACCINE THERAPY. OCULOTOXIC EFFECTS OF VACCINES. INOCULATION.

This subject has been so thoroughly discussed under **Serology**, (and may indeed be regarded as a division of that subject) that little remains to be said here.

It seems that no difference is held—certainly little distinction is made—between the therapeutic applications of *sera* and *vaccines*, and in most instances they cannot be separately discussed. Although a *vaccine* is commonly defined as a *preparation of dead bacteria specific for the particular strain of bacterium from which it is made*, yet a *bacterial serum* is also a specific against special bacterial infections. Hence the wider meaning given to a vaccine, viz., any preparation of a bacillus or its toxins which, on introduction into the body, produces active immunization by the formation of antibodies—a definition that manifestly includes most *serum* preparations.

Autogenous vaccines are those prepared from the body of the same animal, into which they are to be introduced.

Heterogenous vaccines are prepared from tissues obtained from sources outside the animal to be treated.

The ophthalmic surgeon is not expected to make his own vaccines for the treatment of disease unless he has studied the subject and has access to a properly equipped laboratory. The preparation of

autogenous vaccines commonly employed in the treatment of acute cases is the proper work of a competent bacteriologist, while stock vaccines and sera are easily to be had (with full directions for use) from various reliable makers throughout the country. These preparations (See e. g., *Phylacogen*) have been described elsewhere in this *Encyclopedia*.

The *vaccinotherapy* of many bacterial infections of the eye has been discussed under particular diseases. See, e. g., *vaccinotherapy of trachoma*, at the end of the section, **Trachoma**.

Edwards (*Oph. Year-Book*, p. 148, 1909) was one of the earliest successfully to employ heterogenous staphylococcus vaccine. He observed improvement following the injection of from 100 million to 250 million of dead staphylococci, in cases of *hypopion ulcer*, which had not improved on subconjunctival injections of the cyanide of mercury and other local treatment. In 2 or 3 days the pus formation ceased and the ulcers healed rapidly. The pus was taken from a case of acne. The vaccine should be freshly prepared. Here again it is difficult to judge of the effect of the vaccine treatment, as many other factors entered into the experiment. Paracentesis was done in one of the cases, and another had perforated spontaneously.

Shortly afterwards Maddox reported a case in which, on the third day following cataract extraction, the patient suffered an acute attack of gout. Pus appeared at one spot in the incision, and extended in spite of the use of antistreptococcic serum and cauterization of the focus of infection. The eye grew steadily worse until an injection of *Wright's antistaphylococcic vaccine* was given. Then there was steady improvement, and the eye recovered, with vision of 7/12. In a case of orbital cellulitis, due to the staphylococcus aureus, use of the same vaccine was followed by improvement. Allen's experience shows that pneumococcus ulceration of the cornea is especially amenable to vaccine therapy. His results in diplobacillus conjunctivitis, and in tuberculosis, are referred to under appropriate headings elsewhere.

Nicolle and Blaizot's vaccine (the so-called Dmégon) is an atoxic antigonococcal remedy that has had a wide employment in specific eye infections. In addition to the cases reported on p. 8369, Vol. XI of this *Encyclopedia*, Delorme records eight cases of gonococcal conjunctivitis treated with vaccine of Nicolle and Blaizot. Two were not successful, of the six others, five particularly severe, presented corneal ulceration at the beginning of the treatment. The suppuration was arrested in 2, 3, 5 and 6 days respectively. Complete cure with cicatrization of the cornea was obtained in 8, 10, 11, 12 and 19 days. One remained thirty-four days in the clinic.

Stephenson reviews Cuénod and Penet's (*Annales d'Oculistique*, Nov., 1913) experience in the treatment of eighteen infants. Nine were treated by a vaccine containing sensitized living gonococci; the others by Dmégon's vaccine.

As to the first series, the general reaction, although constant, was much less pronounced than in the patients treated by the washed and living gonococci described in the first communication. Excellent results were obtained in five babies. In adults the remedy did not act so well, but one of the two adult patients, aged 18 years, was in a hopeless condition when received, and although the injection did nothing for the necrosis of the corneæ that was present, yet the injections speedily put an end to the purulent secretion from the conjunctiva.

With regard to the second series, no general reaction followed the use of the atoxic vaccine, which had the further advantage that it could be injected into the gluteal region. In a couple of adult patients exceedingly good results were obtained by its employment.

This important communication is best concluded with the author's own words, as follows:—"We conclude from the 26 cases of gonococcal ophthalmia that we have treated during the last eleven months, that Nicolle and Blaizot's antigonococcal vaccine provides us with a certain weapon in the terrible fight against purulent ophthalmia due to gonococci. In the first cases we employed at the same time as the vaccine the ordinary measures (silver nitrate, argyrol, and frequent and copious lavages). In the last cases, without abandoning frequent washings with physiological serum, we suppressed all active collyria, and since these cases have shown the best results, we believe that an incontestible proof has been furnished of the efficacy of the new vaccine."

La Ferla (*Oph. Year-Book*, p. 371, 1916) has reported the use of the *antigonococcic vaccine* of Nicolle and Blaizot in three cases. The first was a man of 20 years, who had suffered for fifteen days with conjunctival blennorrhagia in the right eye, with destruction of a large part of the cornea, and gonococci present. Two days later the left eye became involved. It received the usual local treatment, and in addition the vaccine was given in dose of 20,000,000. The left eye escaped without corneal complications. The other two were cases of ophthalmia neonatorum in which unusually rapid recovery occurred after vaccine injections beneath the skin of the abdomen. The usual local treatment was pursued in each case.

See, also, **Vaccines, Oculotoxic effects of**; as well as **Inoculation, and Typhoid fever.**

F. Lee Masten (*New York State Journ. of Med.*, Sept., 1916) in

speaking of the *diagnosis and vaccine therapy of irido-cyclitis*, says that the studies of Reber, Brown, and Irons make it quite apparent that the former classifications of the causes of uveal disease must be rearranged and that what has been termed rheumatic iritis is a blanket name covering a group of specific infections. Syphilis likely plays a less prominent rôle in disease of the uveal tract than was formerly supposed. The diagnosis of a particular case entails a consideration not only of syphilis, autointoxication, but the search for a possible focus from which infection may be transferred to the eye by embolism, and particularly the tonsils, alveolar processes, and accessory sinuses. The complement fixation tests for gonococcus, pneumococcus, streptococcus, staphylococcus albus and aureus, bacillus influenzae, bacillus coli, and micrococcus catarrhalis are now available and should be made, and if a positive reaction is present, the appropriate vaccine should be administered. Post-operative or intercurrent surgical infections may offer a field for vaccine. Serologists are agreed that in every instance an autogenous vaccine is safer and more certain than a stock vaccine, but that in some infections the stock vaccines compare favorably in action with the autogenous. The administration of vaccine is without danger when in proper dosage and in cases when not clearly contraindicated by serious disease or kidney impairment. Vaccines should be administered under the guidance of one trained by experience in their use.

Vaccines, Oculotoxic effects of. These are almost entirely confined to *antivariolous* and *antityphoid* vaccination. The former is discussed to some extent under **Serology**, under **Vaccinia**, and under **Vaccination**, **Anti-smallpox**. The latter will be considered here.

Numerous cases of *ocular disease following antityphoid vaccination* have been reported since 1916. But most of them seem to have had some other causative factor. Ginestous (*Am. Journal Ophthalm.*, June, 1918) found that one man who complained of impaired vision suffered from a preexisting albuminuric retinitis, and another from tobacco amblyopia. In a third case bilateral kerato-conjunctivitis developed two days after a fourth injection. It was followed by miliary abscesses in the right cornea, and ulceration of the left cornea with perforation. The right eye recovered full vision but the left had a central leucoma. In this case a febrile herpes, accompanying the temperature reaction, may have been due to the vaccination.

Calhoun saw two cases; one of iritis arising one or two days after his first antityphoid and paratyphoid inoculation. The iritis cleared up in about one month leaving full vision. The patient had previously suffered a gonococcus infection. The second patient developed blurred

sight with corneal deposits, vitreous opacities and choroiditis a few days after his third inoculation. He had a 4 plus Wassermann.

F. de Lapersonne (*Archives d'Ophthalm.*, v. 35, No. 11, p. 449, 1917) asks, Can antityphoid vaccine produce eye troubles leading up to blindness? A certain number of cases in which this is supposed to have occurred have been recorded, but the author thinks they have little scientific value. Some of them are due to added infection with staphylo-, strepto-, or pneumococci, due to a faulty technic or a latent infection in the subject. In such cases one may find severe purulent irido-cyclitis, necessitating the removal of the eye. In a syphilitic or a rheumatic subject one may have a recurrence of an irido-cyclitis coincident with the injection, such as one often sees in tuberculous subjects after injections of tuberculin, or after the ocular reaction to tuberculin, or as one sees in syphilitic subjects after the injection of the arsenical preparations.

Such is also the case when a secondary glaucoma asserts itself after the use of the vaccine, as the author cannot understand how the vaccine can produce such a result a month or more after the injection, especially when the injection was not followed by a rise in temperature. A primary glaucoma may make its appearance at the same time as the injection is given, but the causal connection is just as doubtful as in the case of a secondary glaucoma. The conclusion arrived at by the author is that an ophthalmoscopic examination should precede the injection of the antityphoid vaccine, and that syphilitics, arthritics, and tubercular subjects should not receive the injection, especially when they are more than thirty-five or forty years old.

Morax (*Am. Journ. Ophthalm.*, Oct., 1918) reports two cases of herpes consecutive to antityphoid inoculation. In the first case, a slight eruption of herpes on the lower lid followed a second injection, accompanied by slight fever. A third injection, one week later, was followed by rigors and marked increase of temperature. A few days later herpes appeared on the lips and nostril and behind the right ear. Five days subsequently the right eye showed a typical attack of herpetic keratitis. The author also refers to the following three cases of ocular lesions following antityphoid inoculation, but he regards them as coincidences: (1) Paramacular retinal hemorrhage; (2) paralysis of both external recti, associated with generalized paralysis; (3) optic neuritis due to intraocular neoplasm. These four cases were the only instances of ocular lesion observed among 1,700 inoculated soldiers examined. The writer named records another case of herpes following a fourth antityphoid inoculation. The eruption had occurred upon the face, eyelids, and cornea.

Gloagen (*Am. Journ. of Ophthalm.*, Oct., 1918) has also observed three cases of palpebro-ocular herpes following antityphoid vaccination. In the first case, the first two injections presented nothing of special note; the third was followed by fever, headache and pain in the back, on account of which latter symptom lumbar puncture was performed. The same day (i. e., the day following the injection) an outbreak of naso-labial herpes, especially intense upon the right side, occurred. Three days later the right eye became congested, with photophobia; but the patient was not referred to the ophthalmic clinic until three days after this. At that time the reporter noted typical herpetic keratitis, the delicate ramifications of which could be seen by means of fluorescein. Recovery took place at the end of 18 days; leaving, however, a fine corneal opacity which lowered the visual acuity to 0.6.

In the second case, three injections were made without reaction; the fourth was followed by fever and headache. The following morning an extensive naso-labial outbreak of herpes appeared, especially upon the right side; four days later the reporter observed, in addition to the palpebral eruption, a typical herpetic keratitis involving almost the entire cornea. Recovery took place at the end of 25 days, with persistence of a slight opacity which reduced the visual acuity to 0.2.

In the third case the same constitutional symptoms followed a first injection. The same night an eruption of naso-labial herpes took place and the next morning there was photophobia of the left eye. Upon admission to the hospital three days later, the reporter observed patches of herpes disseminated upon both lids of the left eye. The cornea was completely covered. Recovery was slow, requiring 43 days. Vision reduced to 0.1. Thus ophthalmic herpes was observed following the first injection in the third case, the third injection in the first, and the fourth injection in the second.

Prelat (*Archives d'Ophthalm.*, p. 742, Vol. 35, 1918; abs. *Oph. Lit.*, p. 101, 1919) reports a case of acute iridocyclitis, occurring in a man three days after receiving his second dose of antityphoid vaccine. The first dose was given two weeks previously. With both injections the patient had a constitutional reaction with rise in temperature and a transient albuminuria. Following the second injection the patient complained of a severe photophobia, and pain in the eyelids and eyes. The bulbar conjunctiva of both eyes was intensely injected, the iris dull and infiltrated, pupils contracted and did not react. A thick exudate was present in the lower portion of the anterior chamber. In the right a posterior synechia was present, and in about eleven hours after the onset the pupil became deformed. Vision R. 1/10, L. 1/50.

Twelve days later the vascular reaction and pain was increased. A Wassermann test was made and proved strongly positive. In the iris of both eyes several condylomas, the majority located near the iris root, were seen; and the pupillary border was distorted by pressure. Deposits on the posterior surface and in the lower segment of the cornea were present. With intramuscular injections of the iodides of mercury the condition improved and the condylomas reabsorbed. The exudate in the anterior chamber, however, remained, especially in the left eye where it resulted in a seclusio pupillæ. The author was unable to determine whether the acute attack was precipitated by the antityphoid inoculation, or was only a coincidence in a syphilitic process that was about to manifest itself as an irido-cyclitis; and calls attention to the medico-legal importance of such a case.

R. Pacheco Luna (*Am. Journ. Ophthalm.*, p. 488, July, 1919) reports a case of febrile herpetic keratitis following three injections of antityphoid serum. After a study of this case and of the literature he concludes that: 1. There exists no ocular lesion depending directly and exclusively upon the antityphoid vaccine. 2. Herpes febrilis of the cornea is the ocular lesion which is admittedly dependent upon antityphoid vaccine; but in certain cases it deals with a recurrence, and one must admit a predisposition. 3. In a like manner, the cases of iridocyclitis which have a constitutional defect must be considered. A reaction of the vaccine can bring on secondary glaucoma depending upon iridocyclitis. 4. Pyemia, whose cause is a fault of asepsis in the technic, can produce grave complications of metastatic purulent iridocyclitis. 5. Certain lesions of the optic nerves, the optic tracts and certain ocular paralyses, of which, so far, no observations have been published, could be explained by meningeal reaction. 6. An acute primary glaucoma can develop during the reaction of the vaccine. It is not possible scientifically to express in what manner a chronic glaucoma would be aggravated. 7. To admit the action of the vaccine, it is necessary that the ocular manifestations should present themselves during the febrile reaction or immediately after. 8. In certain cases it is not possible to attribute to the vaccine any action at all, it is simply a question of annoying coincidences. 9. It is not prudent to vaccinate luetic, tubercular, and rheumatic subjects, etc., who may have previously had lesions of the uveal tract. 10. There is no reason to deprive those subjects of the benefits of the vaccine who had no former lesions of the uveal tract; who are exempt, therefore, from all former ocular affections. 11. The patient must be submitted to a previous medical examination, and the examination of the eyes entrusted to an oculist. 12. Before judging on a medico-legal matter,

due to the vaccine, it is necessary to use great circumspection and to have a perfect knowledge of all that has been said on the subject.

Vaccinia of the ocular structures. COWPOX OF THE EYE. Vaccinia is probably smallpox in the ox or cow. When communicated to man (in ordinary vaccination or otherwise) it confers a greater or less degree of immunity against variola. Sometimes systemic effects (vaccine rash, etc.) of the vaccination affect the eye; sometimes vaccinia papules are found on the lids or anterior surface of the eye. These are found especially on the *conjunctiva*, *eyelids* and *cornea*, a few authentic reports of which follow:

Jacqueau (*La Clinique Ophtalm.*, June, 1906) reported a case of *vaccine infection of the conjunctiva* in a woman, 30 years of age, who for a long time had had a few slight lesions of the lid margins which had never been cured. Jacqueau saw the case three days after active symptoms appeared. The left eye was involved and there was swelling of the lids with an enormous chemosis and great pain. The preauricular ganglia of the same side and the submaxillary ganglion were enlarged and painful. The lids were swollen and of a pale-yellow. On the palpebral conjunctiva were two small whitish-yellow plaques of a pseudomembranous aspect. There were two small ulcerations of the lower lid. The pupil reacted well and the eye fundus was normal. General condition good and no hyperthermia. Patient denied any source of contagion; she, however, had the care of an infant which had been vaccinated and which had had, eight days previously, well-marked pustules. A bacteriologic examination with cultures was made with absolutely negative results. The case, under the circumstances was, therefore, believed, from its clinical history throughout, to be one of vaccine infection through the former lesions of the eyelids. The active symptoms disappeared in a few days and the eye was restored to normal condition.

During a season of general vaccination in Vienna, Tertsch (1909) saw 19 cases of vaccinal inoculation of the eyes. In 4 cases the patients had inoculated their own eyes, but in the others the accidental inoculation came from other persons. One patient was a boy who got a cinder in his eye, and was infected by his recently vaccinated mother and sister, in their efforts to get it out. He recovered with but little damage to vision. A girl, who had never been vaccinated, became inoculated upon the lid by her recently vaccinated brother. Necrosis of the skin of the lid followed, leaving a defect in the lid margin, and contraction of both lids.

Crampton (*Ophth. Year-Book*, 1912) observed a little child with

vaccinal ulcers on the lids of one eye; the local reactions were singularly slight so that the question arose whether or not they had been caused by a transference of virus from the primary vaccination. Jay F. Schamberg believes that this was the case and that following Bryce's law, secondary auto-inoculated vaccine lesions usually run a more rapid course than the original poek.

Three such cases are also recorded by Casali in one month in an industrial population of over 50,000; 9,496 of whom had been recently vaccinated. While vaccine ulcers in other parts of the body are commonly covered by a blackish crust, such ulcers on the lower lid assume a pseudodiphtheritic appearance, due to their being continually bathed in tears. An ulcer of the upper lid was covered with the usual crust. In doubtful cases the diagnosis is to be settled by search for the diphtheria bacillus on the one hand and the cytocytes of Guarneri on the other.

Julius Fejér (*Centralbl. f. prak. Augenheilk.*, June, 1913) describes the case of a child of 8 years, who rubbed some of the material from a vaccine pustule on her arm into a scratch-wound of her eyelid. The course of the vaccinia thus caused was normal. There was enlargement of the preauricular gland. The condition healed, leaving a barely visible scar.

The danger of this condition is involvement of the cornea, when it takes the form of a keratitis profunda, and leaves permanent nebulae.

A. Casali (*Annali di Ottalmologia*, Vol. XLI, fasc. 4, p. 245, 1914) reports three cases of *vaccinia of the lids* (as above referred to), thus adding to the sixty or more cases mentioned in the literature.

The use of 2 per cent. picric acid ointment gave good results in Casali's hands.

An interesting case of *vaccinal keratitis* is recorded by Caillaud (*La Clinique Ophtalm.*, Jan. 10, 1913). A physician, who was accidentally struck on the eye with a glass vaccine tube which he was breaking, developed in three days considerable pain in the eye, a small ulcer of the cornea, violent pericorneal injection, photophobia, blepharospasm, and lachrymation. The pupil and its reflexes were normal. Later, the corneal epithelium completely desquamated, and at this period a fresh ulceration began at the lower part, and was followed by the objective appearances of interstitial keratitis. Following this again there was a central corneal abscess, which finally broke down, was a long time in cicatrizing, and left an extensive leucoma and very poor vision. The iris had been affected and there were posterior synechiæ.

The writer considers that the primary infection was vaccinal and that infections of different origin were added to it in such a way as to modify the clinical characters of the original infection.

Vacillating cataract. Tremulous cataract.

Vacuoles, Ocular. See *Lacunæ of the eye*, p. 6990 Vol. IX of this *Encyclopædia*.

Vacuum cleansing of the external eye. J. Ohm (*Centralbl. f. prak. Augenheilk.*, March, 1912) has advocated mechanical disinfection of the cornea and conjunctiva by aspiration. He employs a water jet aspirator and glass nozzles with openings of various sizes and shapes. He has used it with advantage in cases of corneal ulcer and corneal erosion, for removing soft matter from the conjunctival sac after operations on soft cataracts, and, finally, for rendering bloodless the field of operation in excision of the lachrymal sac.

Vacuum-tubes. GEISSLER TUBES. Glass tubes containing some particular gas (air, oxygen, etc.) in which a "vacuum" has been made, and which have then been hermetically sealed, and into the opposite extremities of which platinum wires have been soldered, whereby they may be put into the circuit of an electric current. When a current from an induction coil passes, the residual gas glows with a bright light the color of which varies with the nature of the gas in the tube, the glow being brighter round the negative electrode, but being separated from it by a thin, dark layer. If a part of the tube be narrow the glow is broken up into discs or striæ, the cause of which is not clear. These striæ can in some cases be rendered less numerous by slowing the frequency of oscillatory discharge of each make-and-break of the induction coil. The number and position of the striæ is altered by altering the resistance in the circuit. It is not necessary that the platinum terminals should be in contact with the wires of an electric circuit; it is sufficient to put them to widely different potentials: the residual gas then glows without contact. If the vacuum be reduced to 1/400000th of an atmosphere the current will not pass and there is no glow. At about one-millionth of an atmosphere the molecules become so few that there are very few collisions between them. Since the molecules travel in straight lines, any solid obstacle will cast a shadow, and the molecules exert mechanical force and produce heat when they strike. Lenard discovered that the dark or invisible rays emitted from the vacuum-tubes through an aluminum "window" would, in a dark box, take photographs; and in 1895 Röntgen, of Würzburg, found that these dark rays, the so-called Röntgen or X-rays, when passed through the hand or other part of the body would imprint a shadow-picture of the bones on a sensitive photographic plate—a

discovery speedily applied in various ways and utilized in surgery. Comandon and Lemon in France have recently succeeded in taking kinematograph or moving X-ray pictures, and are thus the pioneers in the field of kineradiography. (*Standard Encyclopedia*.)

Vaginitis. As is well known the vaginal discharge in gonorrhea is a fertile source, direct and indirect, of gonococcal diseases of the eye. Duane (*Fuchs Text-Book of Ophthalmology*, p. 157) has pointed out, however, that non-specific vaginitis may also be responsible for *acute purulent conjunctivitis*. He says that we sometimes also observe acute purulent conjunctivitis in small girls of the age of two to ten years, who at the same time are troubled with a vaginal discharge (Arlt). Here are we still dealing with contagion from a virulent vaginal catarrh? Or is the vaginal discharge of these girls a benign catarrh caused by scrofula, anemia, and the like? In some of these cases it has been possible to prove the origin of the vaginal blennorrhea. The children have acquired the latter from their mothers or from other women about them, who were suffering from virulent vaginal catarrh, and had transmitted the latter by soiled clothes, sponges, baths, etc., to the children (Hirschberg). In other cases, the children had been raped by individuals affected with gonorrhea. Here, therefore, we are dealing with a pure vaginal gonorrhea in the children, and, accordingly, it is possible in such instances to demonstrate the presence of the gonococcus both in the secretion of the vagina and in the conjunctiva as well (Widmark). But it would be going much too far to regard the vaginal discharge in little girls as true gonorrhea in all cases in which infection of the conjunctiva results from the discharge. Here, just as in the case of ophthalmia neonatorum, a non-virulent, simple catarrhal secretion of the vagina is in position to excite an inflammation of the conjunctiva, which in this instance runs a less severe course. The distinction from a true blennorrhea could be made in such case only by microscopical examination of the secretion for gonococci.

Vagotonia. Irritability of the vagus or sympathetic nerve. See **Thymus**.

Vagotonics. Patients whose pulse rate slows up as the result of the oculocardiac reflex. See p. 8470, Vol. XI of this *Encyclopedia*.

Vaginal tunic. A synonym for Tenon's capsule.

Vagus. PAR VAGUM. TENTH CRANIAL NERVE. The pneumogastric nerve, supplying sensation and motion to the ear, pharynx, larynx, heart, lungs, esophagus and stomach.

Michael Goldenburg (*Journ. Am. Med. Assoc.*, p. 104, July 14, 1917) believes that this nerve is closely related to certain ocular

affections and that, in particular 1. Ophthalmia eczematosa or *phlyctenular disease* is not a true pathologic entity but symptomatic manifestation of a systemic disturbance. 2. Tuberculosis, syphilis and sepsis can be excluded with certainty as causal factors. 3. Phlyctenular disease is in all probability one of the expressions of vagus system irritability produced by some toxic agent, resulting from faulty carbohydrate chemism. 4. Correction of the chemism by carbohydrate-free diet and control of the vagus hypertonia through the topical and internal use of atropin yield the best and quickest possible therapeutic results.

Valbonais, Bourchenu de. A French historian, concerning whom extremely little is known. He was born at Grenoble, France, in 1651, and, at the age of 21, took part in the naval engagement of Solbaye. Shortly afterward, he lost his sight. He then resigned from the army, and betook himself to literature. He wrote a history of Dauphinay, and a number of genealogies.—(T. H. S.)

Valdes, Daça de. Licentiate and notary of the Inquisition at Seville. In 1623 he published a work on the use of spectacles, the first of its kind in history. In this work he furnishes the earliest mention of cataract-spectacles, stating that, for distance vision, the patient should wear 11-12 "strengths"; for reading, however, 20 strengths. *Mirabile dictu*, it was more than a century before this important discovery was noted and adopted by the medical profession. Even then, the patient seems never to have been fitted by the physician himself, but to have been referred to a "dealer in spectacles."

The title of the Valdes monograph is *Uso de los antoios para todo genero de vista; En que se ensena a conocer los grada que a cada uno le galtan de su vista, y los que tienen qualesquier antojos*. 8 vo. Impresso en Sevilla, por Diego Perez. Año de 1623. Woodcut portrait of the author and diagrams. His work, now exceedingly rare, contains interesting drawings, and tables for testing sight.—(T. H. S.)

Valerius Aper. An ancient patient, whose case-report appears on a votive tablet found in the Tiberine Temple of Æsculapius at Rome. The report is as follows: "The oracle advised a blind soldier, Valerius Aper, to make of the blood of a white hen a collyrium, which should be employed for three days. And, seeing again, he came and praised the god publicly." For an illustration of the tablet on which this case-report is found, see, herein, **Ophthalmology, History of.**—(T. H. S.)

Validol. This clear, syrupy liquid is a menthol preparation. Neustätter advises its internal use in 20-drop doses for *scotoma scintillans* (q. v.).

Valk, Francis. A famous ophthalmologist of New York City, inventor of numerous ophthalmic instruments and author of the well known handbooks, "*Errors of Refraction*" and "*Strabismus*." He was born at Flushing, N. Y., son of a well known physician, William W. Valk, and Jane Sherwood (Jones) Valk, Oct. 28, 1846. He received a classical training at Washington College, Chestertown, Maryland, and the M.D. at New York University in 1878. During the war he enlisted in the northern army. For a time he was assistant surgeon to the Manhattan Eye and Ear Infirmary, and later surgeon. For very many years he was ophthalmic surgeon to the New York Dispensary and surgeon and visiting ophthalmologist to the Randall's Island Hospital, as well as consulting ophthalmic surgeon to the Thrall Hospital, Middletown, N. Y. He was professor of ophthalmology at the New York Post Graduate Medical School for many years, and emeritus professor for a very brief time before his death. He was a fellow of the New York Academy of Medicine, of the American Academy of Ophthalmology and Oto-Laryngology, the Clinical Society of the New York Post Graduate Medical School and Hospital, and many other medical societies, both general and special. Among the instruments which he invented were the twin strabismus hooks and needle-point cystotome.

Dr. Valk was a man of striking appearance and personality. He was six feet high, erect, slender of build, and with very sloping shoulders. His hair, mustache and imperial were all, in his later years, snow-white. He affected the dress of a Methodist minister, and, although a northern man by birth and residence, was almost invariably mistaken for a southerner. The writer remembers well his striking southern drawl and southern pronunciation. He almost always arose, at meetings, to discuss muscle conditions of the eyes, and was very clever, thorough, and forceful in his arguments. When speaking, he had a way of stooping over and gently bringing together the palms of his hands, which gave to all that he said an air of special earnestness. He was always kindly and sympathetic, and the writer can never forget the warm-hearted manner in which he used to say: "Good-bye" to a student at the "P. G.," and to add: "Now *some* day, Doctor, *some* day, I know we shall meet again." He also had a way of asking students who had finished his course in ophthalmology at the Post-Graduate, to write to him fully whenever they had a case on hand which gave them special trouble. "I shall always be glad to hear from you, you know," he would say. And his listener knew that he meant it.

Dr. Valk married, at Washington, D. C., in August, 1874, Miss

Marian C. Easby of that city. To the union were born the following: Francis M. Valk, Mrs. Elizabeth V. Hay, and Jane Sherwood Valk.

The Doctor died at St. Luke's Hospital, New York City, November 5, 1919.

One cannot refrain from adding, in the words of the dear old teacher himself: "Good-bye, Doctor, I know that, *some* time, we shall meet again."—(T. H. S.)

Valsalva, Antonio Maria. One of the most celebrated otologists of all time, and a man of some importance ophthalmologically. Born at Imola, in the Romagna, Feb. 16, 1666, he studied mathematics, the natural sciences and medicine at Bologna, at which institution he was graduated in 1687. In 1697 he was made professor of anatomy at Bologna. He died Feb. 2, 1723. Valsalva made a number of very important discoveries in general and special anatomy. In otology he is chiefly remembered for the experiment which still bears his name. In ophthalmology, he is now of little importance, and yet he was one of those who introduced into Italy the "new learning about cataract." Throughout all antiquity, the middle ages, and even the earlier centuries of the present period, it was universally supposed that a cataract was a deposit of corrupt and inspissated "humor" in a (wholly imaginary) space between the pupil and the lens. About 1643, Quarré, a Frenchman, taught (theoretically only) that a cataract is simply a hardening and clouding of the crystalline lens. Rolfinek, a German, in 1656 made actual anatomical demonstrations of the truth of this theory. One or two others spoke or wrote in feeble support of the new theory, and then the matter dropped for thirty or forty years. It was, however, revived by two Frenchmen, Brisseau and Maître Jan, in the opening years of the 18th century. A bitter fight ensued in France—a fight which lasted till about the beginning of the nineteenth century, and then, of course, resulted in a permanent victory for the advocates of the new doctrine. The great Heister was the means of carrying the new and highly important doctrine into Germany. To Valsalva, however, as well as to several of his Italian confrères—Morgagni, Lancisi, Benevoli—belongs the credit of the introduction of the new teaching about the seat and nature of cataract into Italy—(T. H. S.)

Valsol. VALSOLUM. This is an oxygenated petroleum, like vasogen and petrogen, and is marketed not only pure but as containing definite amounts of ichthyol (10 per cent.); iodine (6 and 10 per cent.); iodoform (3 per cent.); tar (25 per cent.), and other preparations suitable for applications to the eye. Valsol may be also made up with nearly every variety of medicament suitable for application to the skin.

Valve, Huschke's. See **Rosenmüller's valve.**

Valve, Rosenmüller's. See **Rosenmüller's valve.**

Valves of the lachrymal canals. In addition to the matter on p. 350, Vol. I of this *Encyclopedia* the complete list of these organs, by Aubaret, (*Archives d'Ophthalm.*, April, 1908; review by Jameson Evans, *Oph. Review*, p. 242, Aug. 1908) is given, the writer thus classifying the various *mucous folds or valves* in connection with the lachrymal passages: 1. Inferior valvular fold: valve of Bianchi; valve of Cruveilhier; valve of Hasner. 2. Valvular folds of the middle segment of the canal: valve of Taillefer. 3. Valvular folds at the upper end of the canal: valve of Bérard; valve of Krause. 4. Valvular folds of the lachrymal sac: transverse fold of the internal palpebral ligament. 5. Valvular folds of the saccular orifice of the canaliculi: valve of Rosenmüller; valve of Husehke. 6. Valvular folds of the canaliculi: valve of Foltz; valve of Boehdalek.

1. The most important of these is the *inferior valvular fold*. This generally goes by the name of the valve of Hasner but it was first described by Bianchi, who recognized the valvular character of the structure, which allows of the free passage of tears into the nose but in most cases prevents regurgitation of fluids from the nose into the conjunctival sac. He also described cases in which, owing to insufficiency of the valve, fluids and smoke could be forced up along the nasal duct and canaliculi. Bianchi also declared that a stylet could be easily passed down the duct but gave no instructions as to the method of performing the manoeuvre, described later by Laforest. Morgagni opposed Bianchi's views and considered that this mucous fold was no more a valve than the mucous folds at the entrance of the ureter into the bladder. Vesignie held similar views. The descriptions of the valve given by Cruveilhier, Bérard, Hasner and Richet are based on those of Bianchi. Taillefer, Husehke and Osborne detailed the varying forms which the inferior opening and valve may assume. Sappey showed that the diameter and form of the orifice varies with its relations to the meatus. When it opens high up it is round or infundibuliform and large; as it approaches the floor it gets more vertically oval, so that at a distance of 4 or 5 millimetres below the meatal roof it becomes a mere vertical slit sometimes very difficult to see. Although formerly valves in the form of a diaphragm with a small hole in the middle and semilunar valves were described, present day anatomists regard these mucous folds, so varied in size and position, as not worthy of the name of valves. Complete obstruction of the meatal opening of the nasal duct is a frequent factor in dacryocystitis in the newly-born (Rochon Duvigneaud) and may lead to the formation of a terminal cyst extending almost to the floor of the nose (Boehdalek). This must

not be confounded with a slight dilatation of the lower end of the canal observed by Cruveilhier and Aubaret.

2. *The valvular folds in the middle segment of the nasal duct.* The only fold of any consequence goes by the name of the valve of Taillefer. It is inconstant (6 per cent.) and its free edge is generally directed upwards. It is more marked in the newly-born and tends to disappear with advancing age. It is so variable in size, position and form that it can hardly be looked upon as a valve in the proper sense of the word, although Aubaret found that in some rare cases, where the valve of Hasner was insufficient, the valve of Taillefer prevented the regurgitation of fluid forced up the duct from the nose. Sometimes these folds are long and being directed somewhat parallel to the axis of the duct form diverticula which simulate duplication of the canal.

3. *Valvular folds at the junction of the sac and the upper end of the canal*—valve of Bérand or valve of Krause. This fold is probably produced as the result of the formation of a cul-de-sac through the mechanical distension of the part of the sac below the internal palpebral ligament. Its base is attached to the lower and outer part of the sac and its free edge is directed obliquely upward and inwards. Very exceptionally it may be divided horizontally in the form of a sphincter or diaphragm with a small hole in it. Its position, size and shape are very variable.

4. *Valvular folds of the lachrymal sac.* In the newly-born the mucous membrane of the lachrymal sac is of the type designated utricular by Aubaret. In the adult most of the folds disappear. Of those that remain one is found on the anterior wall and corresponds to the position of the internal palpebral ligament. It is marked only in cases of distension of the sac and in some cases may be so prominent as to give rise to an apparently bilocular sac. In some cases a vertical fold may be the cause of sacculation, or the folds may be such as to give rise to an appearance of acinous glands.

5. *Valvular folds at the saccular orifice of the canaliculi.* The canaliculi may enter directly, by one or two openings, or indirectly, by a dilated diverticulum known as the sinus of Maier, which is either a saccular prolongation of the sac or a dilatation of the united canaliculi. At the upper part of the canalicular duct or sinus, Rosenmüller described a valvular mucous fold and at its lower part Huschke described a similar fold. The latter is semilunar and its free edge is directed upwards and tends to close the entrance of the canaliculi. Bérand described a small tubercle on its free edge. Its weight was supposed to keep the valve open except when pressure was applied from the side of the sac.

6. *Folds and valves of the canaliculi* are only found in rare cases. Bochdalek described an annular fold constricting the canalicular punctum. Beyond this there is a small infundibuliform dilatation and then a constriction called *angustia* by Gerlach. In the neighborhood of the *angustia* there is a valvular fold which has been called the valve of Foltz. These folds should almost be regarded as congenital anomalies. Mucous folds towards the saccular ends of the canaliculi may be such as to form diverticula and give rise to an apparent formation of two or even three canals.

The question of the valvular nature of the mucous fold at the meatal end of the lachrymal duct was the cause of a prolonged controversy between Bianchi and Morgagni. Richet considered that it always formed an efficient valve and on that assumption formulated his aspiratory theory of the excretion of tears. Bert found that in some cases the valve was unable to prevent the regurgitation of fluids from the nose. In these cases he found that the meatal opening of the duct was large and open and the mucous fold very small. In the cases in which fluids could not be forced up the lachrymal passages the valve of Hasner was well-developed and closed the opening when pressure was applied to the liquid in the nose. The orifice was also very small, punctiform or even invisible. These two types were met with in one head examined by Bert. Direct injection into the canal by means of a fine canula was always followed by regurgitation into the conjunctival sac, so that the valves of Bochdalek, Rosenmüller, Bérand and Taillefer were considered to be always inefficient.

Bert's experiments were made by blocking up all the openings into the nose except the nasal duct and applying pressure to the liquid with which the nose was filled. Aubaret constructed an apparatus which gives more exact results. He applies the pressure directly to the inferior orifice of the nasal duct by means of different sized funnel-shaped glass tubes—if necessary surmounted with rubber rings—which fit accurately over the duct openings without causing any obstruction of the canal by pressure. The glass tube is connected by means of rubber tubing with a pump and a manometer to record the force of pressure or aspiration applied.

Aubaret finds that in those cases in which the valve is competent the lower orifice of the duct is prolonged into a deep, narrow groove of varying length and the valvular fold stretches between the edges of this groove.

Where the lower opening is wide and large and the edges of the valve do not reach the walls of the duct the valve is incompetent.

In about 90 per cent. of adults the latter condition prevails, while

a competent valve is comparatively rare (4 per cent.). Whether this is due to an atrophic condition of the mucous membrane of the nose and nasal duct in advancing age remains to be shown.

Valvular disease of the heart. See **Heart disease**, **Eye symptoms in**, p. 5719, Vol. VIII of this *Encyclopedia*.

Van der Hoeve's symptom. See **Hoeve's (van der) symptom**, p. 5969, Vol. VIII of this *Encyclopedia*, as a *sign of neighboring sinus disease*.

In addition, D. Gjessing (*Graefe's Archiv. f. Ophthalm.*, Vol. 80, Part 1), reports the case of a previously healthy young man of healthy parentage who became almost totally blind within six months because of optic atrophy. Associated symptoms included color-blindness, bilateral concentric ring scotomata, which changed in shape and position as the case progressed, facial paresis, increased right patellar reflex, absent right Achilles' reflex and bilateral empyema of the posterior ethmoidal cells. Some improvement followed drainage of these cavities.

He suggests a beginning disseminated sclerosis or a hysterical tendency as possible, but not very probable, causative factors of the ring scotomata in this case. As to a sinusitis being the cause not only of the optic atrophy but also of the ring scotomata, he alludes to very similar cases reported by Wood and Ham. The latter found several concentric ring scotomata which changed their form with the onset of convalescence. He considered them of functional origin, a view to which Gjessing inclines.

Van Fleet, Frank. A distinguished New York ophthalmologist. Born in New York City on Mar. 31, 1860, son of Henry S. and Esther Flan-dreau Van Fleet, he received his medical degree at Bellevue Hospital Medical College of New York City, in 1881. Settling in New York as ophthalmologist, he soon had an extensive practice and a wide reputation.

He was executive surgeon to the Manhattan Eye, Ear and Throat Hospital for seventeen years, and at the time of his death was president of the Board of Surgeons of the same institution. He was a Fellow of the New York Academy of Medicine and of the American College of Surgeons, and was once President of the New York County Medical Society. He was also Treasurer of the New York State Medical Society and chairman of the legislative committee of that body for very many years. During the late war he gave much time to the examination and treatment of soldiers whose eyes had been injured by poisonous gas. He wrote many articles that cannot here be listed.

Dr. Van Fleet was rather a stout man, 5 feet 6 inches high, of a fair

complexion and with blue eyes and blonde hair. As a rule he wore a mustache. He was a very quiet man, but courteous and friendly. He was a Republican; a member of the Methodist Episcopal church; a hard student of the Bible; a very devout Christian.

In 1883 he married Carrie Blair Oakley, by whom three children were born—Harry, Raymond Oakley and James Flandreau, the latter a lieutenant in the Medical Corps of the Navy in the late war.

Dr. Frank Van Fleet was found dead in his office at 17 E. 38th St., New York City, April 5, 1919.—(T. H. S.)

Van Giesen's stain. See p. 6911, Vol. IX of this *Encyclopedia*.

Van Lint cataract operation. See p. 1640, Vol. III of this *Encyclopedia*.

Vaporole. See Iodin, p. 6563, Vol. IX of this *Encyclopedia*.

Vaquez's disease. Cyanosis. See **Erythremia**, p. 4516, Vol. VI of this *Encyclopedia*.

Variable base. In alphabets and print for the blind (q. v.), this term is used to designate the plan by which the horizontal space allotted to each character varies with the width of the character, as in the New York Point.

Variable prism. Risley's rotary prism. See p. 4692, Vol. VI of this *Encyclopedia*.

Varicella, Ocular relations of. CHICKENPOX. In addition to the description on p. 2056, Vol. III, it may be said here that Chavernac (*Annales d'Oculistique*, July, 1908; abst. in *Oph. Review*, Sept., 1908) has reported *double optic neuritis after varicella*.

The patient was a boy, 11 years of age, who had an attack of chicken-pox from which he made an uninterrupted recovery. Soon his sight began to fail and in four months he was unable to count fingers at a distance of one metre. The boy was taken to several surgeons who all diagnosed optic neuritis; various forms of treatment were employed, including mercurial frictions and injections, strychnin, and the continuous current, but without any improvement in his vision.

The disease had persisted for nine months when Chavernac saw the patient for the first time. An inquiry into his family and personal history failed to elicit anything of importance. The boy showed signs of general anemia. On ophthalmoscopic examination the optic disc in each eye presented the usual signs of swelling, indistinctness of its margins, etc., and several fine hemorrhages over its surface; there was a central scotoma for red and green, while the fields were contracted peripherally by 20° all round.

For treatment Chavernac made use of subconjunctival injections of hetol (cinnamate of soda, 1 per cent. solution) 5 or 6 drops at a

time, at intervals of two or three days, with the result that after 15 such injections the boy's vision rose from 2/50 in each eye to 0.1 and 0.6 in the right and left eyes respectively; the central scotoma disappeared, and the fields became fuller. After an interval of several months this treatment was resumed and the vision was still further improved (to 0.4 and 0.9). When the boy was seen two years later this improvement was found to be maintained.

Chavernac deprecates the treatment of such cases of toxic origin with mercury, but recommends hetol, and emphasizes the fact that a good result may be obtainable even where the optic neuritis has lasted for many months.

Jesse Wyler (*Journ. Am. Med. Assoc.*, p. 1476, May 19, 1917) records a *corneal ulcer from varicella*. A girl, aged 5 years, had been confined to the house for four days by a rather mild attack of varicella. The child was well nourished, and the hygienic surroundings were all that could be desired. The mother related that on the second day of the eruption the child became unable to open the right eye, and tears from this eye constantly flowed over the cheek.

The child had a few scattered crusts over the face and chest, no abnormal temperature, and felt well excepting for the eye, which was kept closed. The upper lid was slightly swollen and the tarsal and bulbar conjunctivæ faintly reddened with a ciliary congestion at the limbus. In the center of the cornea was a punched-out area perfectly round, which measured about 2 mm. in diameter. The edges were sharply marked and the base of the ulcer was deep and grayish. Staining with methylene blue and fluorescein gave a beautiful demonstration of a blue center with a greenish border. The iris was faintly greenish but reacted slowly. The rest of the cornea was clear. Atropin 1 per cent., powdered dionin and yellow mercuric oxid, 5 per cent., were used and a bandage applied daily. The ulcer showed no tendency to spread, slowly healed, and in about two weeks was completely covered with epithelium, with a remaining facet which gradually filled out to the level of the cornea. Applications of fibrolysin, and strong ointment of yellow mercuric oxid up to 20 per cent. were used to clear up the opacity and, subsequently, the vision of the right eye which, before the attack, had been normal, was 6/36. The macula was thinning slightly.

Wyler believes that this ulcer was the eruption of a pock on the cornea, for: 1. It appeared simultaneously with the skin lesions. 2. It was too large for an ordinary phlyctena and there were no other signs of eczematous conditions generally or locally. 3. The healing

was much slower than in ordinary keratitis. The vision of the affected eye of the patient was eventually 6/24.

Only one other corneal involvement following chickenpox has been described. The case, reported by Terson, is strikingly similar. The patient was a girl aged 18, who had a benign attack of varicella. On the second day a corneal lesion appeared, which persisted. Several days later examination showed a grayish ulceration exactly in the center of the cornea without hypopyon or iritis. It was the size of a pea and quite round. Healing was rapid under xeroform ointment. The round form of the ulcer and absence of all other causes made Terson ascribe the condition to a ruptured vesicle due to varicella. He also makes mention of a second case of chickenpox with optic neuritis as a complication, and quotes the patient of Fuchs who had eyelitis.

Leslie Paton (*Am. Journ. of Ophthalm.*, August, 1918) showed a patient in whom *chickenpox was associated with neuroretinitis*. There is only one other case of the kind on record, though neuroretinitis has been recorded in connection with poliomyelitis. The present patient had had nothing else amiss with him, and his blindness came on suddenly on the third day of the chickenpox. The large central scotoma gradually cleared up.

Varicose nerve-fibres are sometimes found in the retina as the result of edematous post-mortem changes or of imperfect hardening of sections. As *cytoid bodies* they were discovered by H. Müller and thought to be characteristic of albuminuric retinitis but have since been found in association with other processes. They are seen, for example, in wounds of the retina, appearing, within twenty-four hours of the trauma, both centrally and at the periphery. The cut ends of the nerve fibres swell up (Parsons, *Brain*, 25, 1902) on the central aspect of the wound but not so markedly toward the periphery; hence the former are globular, the latter club-shaped.

Varicose veins. John A. Tamisiea (*Journ. Am. Med. Assocn.*, p. 497, Aug. 16, 1919) devised a method of treating this disorder in the B. E. F., which may be of use in ophthalmic practice. To a piece of silver wire (used for suturing bones) was attached the base of an ordinary 0.303 rifle cartridge. First the sides were filed off and then the cap bored through and the silver wire run in and secured with solder. This wire had to be quite pliable, but not too much so. "The other end we beaded over a Bunsen burner. The wire in all was 40 inches long. We would put a tourniquet on the affected thigh and pick up the internal or external saphenous as the case happened to be, and then would make incision over it about 1 inch long, pick up the vein with hemostats, and tie off the lower end of it (distal end). Then we

would pick up the vein by the same incision and tie off the upper end (proximal end). To open the vein we applied the hemostats to the edges and held them open while we inserted our wire. We then gently pushed the wire up and followed its course with our hand on the leg. This was usually done from the bottom, as in the pulling up on the wire we took all the minor tributaries as well as the main vein. When the bead appeared at the higher incision we grasped it well and had an assistant hold the foot firmly, and pull hard until our wire was entirely out and then we would have the vein gathered up on the wire in its entirety.

"Very little if any hemorrhage resulted. We then put a stitch in each incision and an alcohol dressing over it. When our patients awaked they would move their legs around and would be greatly disappointed to find that they had no large bandages, no pain, and really no reason for asking to get to 'Blighty.' These patients were usually sent back to the lines in from ten to fourteen days."

Varicose veins of the eyelids. These do not differ from varices of other skin surfaces.

Varicositas conjunctivæ. (L.) *Cirsophthalmia*. See p. 2283, Vol. III of this *Encyclopedia*.

Variola, Ocular relations of. **SMALLPOX.** This topic is discussed under **Small-pox**. It may be said here that while the lid pustules are those most commonly seen yet the conjunctival and corneal eruptions are the most dangerous. *Hyperemia of the conjunctiva* usually accompanies variola. About the fifth day of the eruption the conjunctiva may show a catarrhal form of inflammation which readily yields to simple treatment. The intensity of the conjunctivitis is in proportion to the involvement of the face and eyelids. Pustules rarely form upon the conjunctiva. When they occur they resemble phlyctenulæ. A favorite site for the pustules is the area between the corneal margin and the inner or outer canthus. Sometimes they appear on the limbus, in which event corneal ulceration is likely to supervene. Chance states that pustules may form on the tarsal conjunctiva and on the caruncle, but are never found at the fornix. In the pustular type of variolar conjunctivitis severe inflammatory symptoms, such as chemosis and profuse discharge, are present. Subconjunctival hemorrhages may occur in hemorrhagic variola.

In the treatment of the conjunctivitis of variola mild antiseptic solutions should be used.

Variola of the lids. See p. 5029, Vol. VII of this *Encyclopedia*.

Variolar ulcers of the cornea. See p. 3521, Vol. V of this *Encyclopedia*.

Varix of the disc. Varicose formations in and about the papilla are occasionally seen. Axenfeld (*Ophthalmic Year-Book*, p. 265, 1912) from his observations agrees with Fuchs (see *Year-Book*, p. 214, 1900) that the appearance of varix formations on the disc is due to the formation and distribution of collateral circulation in thrombosis of the central vein of the retina.

In a patient who had dizziness accompanied by visual disturbance Landolt found an accessory filiform inferotemporal artery, the circulation being evidently very greatly diminished. A short branch connected this with the normal superior temporal artery. There was no common venous trunk. From the inferior a short tortuous dilated branch ran upward. Its course paralleled the anastomotic arterial branch. The diagnosis was obstruction to the circulation within the optic nerve.

Varix of the eyelids. See **Varicose veins of the eyelids.**

Varix of the orbit. See p. 466, Vol. I of this *Encyclopedia*.

Varix of the retina. VARICOSITY OF THE RETINA. Dilation of the retinal vessels has been considered under a number of captions in his work. For example, see p. 462, Vol. I; as well as **Miliary aneurism of the retina**, p. 7705, Vol. X; and **Retina, Angiomatosis of the**, p. 11190, Vol. XIV of this *Encyclopedia*.

Varolio, Costanzo. A famous Italian anatomist, who first described the "Pons Varolii" and who was the first to point out that the crystalline lens is so situated on the optic axis that that line passes a little external to the lens-center. Born in Bologna in 1543, he studied at the Bolognese University, and there became professor of anatomy and surgery. In 1753 he removed to Rome, in order to accept the chair of Wisdom and to become physician-in-ordinary to Pope Gregory XIII. Two years later (1755) he died, aged only 32. His chief writings were: "*De Nervis Opticis Nonnullisque Aliis praeter Communem Opinionem in Humano Capite Observatis Epistola*" (Padua, 1572) and "*De Resolutione Corporis Humani Libri Quatuor*" (Frankf. 1591).—(T. H. S.)

Vasa hyaloidea. The embryonic blood vessels of the vitreous. See **Development of the eye.**

Vascular fasciculus. (Fisher.) The leash or band of vessels associated with an advancing corneal ulcer. The vessels, in this instance, lie in a depression or furrow representing the cicatrized path of the ulcer.

Vascular growths. See **Tumors of the eye.**

Vascular keratitis. See p. 6823, Vol. IX of this *Encyclopedia*.

Vascular systems of the eye. VASCULAR SUPPLY OF THE EYEBALL.

See **Bloodvessels of the eye**, p. 1228, Vol. II of this *Encyclopaedia*.

Vasculitis, Retinal. See p. 614, Vol. I and p. 11193, Vol. XIV of this *Encyclopaedia*.

Vaselin. This is the registered name given to a useful and well known product manufactured by the Cheeseborough Mfg. Co. A yellower compound, a part of the residue from the distillation of petroleum, is sold in Germany but, as Ohlemann points out, is not so useful as the American variety as an ointment base because it contains and will absorb very little water. It is obviously of advantage to use a base that has solvent powers, and since vaselin in itself is non-solvent that variety which has or retains the larger proportion of water is to be preferred. The German variety is not as viscid as the American and breaks off short when raised on a probe, while the American may be drawn into long threads. The latter is very popular both here and abroad as an exipient. Some writers attribute germicide qualities to ordinary Cheeseborough vaselin; if so it probably acts by furnishing a protective coating to the tissues in which bacteria do not readily flourish. There is a purified or "white" vaselin in the market (Cosmoline) but the cheaper variety is to be preferred not only as a basis for salves but for use alone as a soothing protective. The official Petrolatum (q. v.) answers all the purposes of vaselin and should for obvious reasons, be ordered under that title. See, also, **Cosmoline**.

Vaselin, Oxygenated. See **Vasogen**.

Vaselin, White. See **Cosmoline**.

Vasanol. A useful ointment-base for ophthalmic agents. It consists of an emulsion of soft paraffin 28 ounces, cetaceum $\frac{1}{2}$ ounce, and water 8 ounces. It readily mixes with water, forming a neutral emulsion which is easily absorbed by the conjunctiva and skin.

Vasi. (It.) Blood vessels.

Vaso-constrictors. These remedies produce contraction of both arteries and veins of the anterior plexus, accompanied by blanching of the conjunctiva, complete whitening of the sclera and more or less pallor of the palpebral skin. The conjunctival vessels are reduced to microscopical threads and the superficial veins generally require a lens to locate them.

We are principally concerned in the local vessel-contractors which are chiefly cocaine, the majority of the cycloplegics, and the suprarrenal extracts. The two first are fully discussed elsewhere; of the last named it may be said that Bates (*New York Medical Journal*, May 16, 1896) drew our attention to the affects of an extract of su-

prarenal capsule upon the eye and showed that it acts as a powerful vaso-constrictor. Takamine, through Parke, Davis & Co., put at our disposal adrenalin hydrochloride, a much more convenient and cleanly preparation of the suprarenal body. One of the early preparations was the liquid extract of suprarenal glands made with glycerin, one part being equal to one part of the fresh gland. Since that time numerous substitutes for this useful agent have been marketed but it cannot be said that any of them is more valuable in eye surgery, although several are cheaper and probably of equal importance from the ophthalmic standpoint.

Besides adrenal, adrin, atrabilin, hemostatin, suprarenalin, adrenin, suprarenin (both animal and synthetic) we have hemisin, renaglandin, adnephryn, paranephryn, renastyptin and a dozen other substitutes for adrenalin.

Most of them are, like the original adrenalin chloride, sold as 1:1,000 solutions with or without some preservative (chloretone, common salt, boric acid, phenol, etc.) and protected from light and air in glass-stoppered, amber bottles.

It is still believed by some surgeons that the vaso-constrictor qualities of suprarenal extract may be utilized in the treatment of external diseases of the eye. Such a position ignores the well-worn pathological idiom that local distress is the cry of the affected parts for blood. The continual hyperemia of the oculo-vascular system is merely nature's effort to meet germicidal and other hostile invasions of the eye-coverings by a free supply of blood. To arrest this flow of nutritive fluids is to postpone or prevent a cure of the disease. Yet as local hemostatics and as adjuncts to eucain and cocain (eucaprein, cocarenalin, caprenalin), eserine, atropin, fluorescein, suprarenal derivatives have an important place in ophthalmic practice. See, also, **Astringents**.

Vasogen. Oxygenated vaseline. This yellowish-brown, viscid mass, with an alkaline reaction, forms an emulsion with water and renders many active remedies, especially a number used in ophthalmic surgery, readily absorbable. Such a list includes creolin, menthol, iodine, ichthyol and pyoktanin.

The advantage vasogen possesses over even the watery forms of vaselin or petrolatum is in its solvent powers. It is said to be capable of absorbing 100 per cent. of water without losing its consistency. A sterile liquid vasogen is on sale as well as capsules containing various combinations of it with drugs for internal administration. Lehn and Fink, the agents for this preparation, also supply both the pure or inspissated vasogen, as well as the liquid form, in various combinations and doses for external use, several of

which, especially those with iodine, thiol, ichthyol, iodoform, salicylic acid, mercury and menthol, are of interest to the ophthalmologist. See, also, **Petrogen**; as well as **Iodine-vasogen**.

Vaso-motor fibres. VASO-MOTOR NERVES. The fibres of a vaso-motor nerve convey impulses from a vaso-motor centre to the blood-vessels and cause either constriction with consequent narrowing, or dilatation with consequent widening of the vascular channel.

Vaso-motor inhibition. A restraint of the nervous mechanism tending to narrow the calibre of the blood-vessels. It may be brought about by either depressor or vaso-dilator fibres.

Vater, Abraham. A celebrated professor of anatomy at Tübingen, of some importance ophthalmologically. His father was Christian Vater (ordinary professor of medicine at Wittenburg and author of "*Physiologia Experimentalis*" and "*Semiotica Medica*"). The subject of this sketch was born at Wittenburg, Dec. 9, 1684,* received his philosophical degree in that city in 1706, and his medical degree four years later. He studied afterward in many lands, became professor of anatomy and botany in his native city, established there a wonderful anatomical museum, and died in 1751. In addition to important anatomical and botanical compositions, he wrote: 1. *Abrahami Vater et J. Christiani Heinicke, Diss., qua Visus Vitia duo Rarissima, Alterum Duplicati, Alterum Dimidiati Physiologice et Pathologice Exponuntur*. (Wittenburg, May 25, 1723.) Written, as the title shows, in conjunction with one Christian Heinecke, concerning whom nothing else is known. 2. *De Instrumento ad Determinandas Lucis Refractiones* (1751).—(T. H. S.)

Vathek. The ninth caliph of the race of the Abbassides, and grandson of Haroun al-Raschid. "When he was angry, one of his eyes became so terrible that whoever looked at it either swooned or died."—(T. H. S.)

V. C. Symbol for the acuity of *color vision*.

Vectis. A wire loop or spoon used to remove the lens by traction. See **Spoon**.

Veils and eye-strain. The habit of wearing dotted or figured veils is responsible for a good deal of eye strain. When they are used for protecting the face and keeping the hair smooth, or keeping the headgear in position, they should be thin, with a large, uniform mesh. The Editor (*Boston Med. and Surg. Journ.*, Dec. 3, 1896) has reported the result of a number of experiments bearing out these contentions.

*Not 1644, as stated by the usually correct Hirschberg, as this would make the man 107 years old at his death.

Veins, Ophthalmic. See p. 409, Vol. I of this *Encyclopedia*. The ligation of the ophthalmic vein in *pulsating exophthalmos* is described on p. 4873, Vol. VII, and (especially) under **Pulsating exophthalmus** p. 10429, Vol. XIV of this *Encyclopedia*.

Veitstanz. (G.) Chorea.

Velpeau, Alfred Armand Louis Marie. A famous French surgeon, inventor of "Velpeau's bandage," and a man of some importance in ophthalmology. Born May 18, 1795, at Bruch (Inde-et-Loire) he studied at Tours and Paris, at the latter institution receiving his degree in 1823. In 1828 he became surgeon to Sainte-Antoine and in 1830 to La Pitié. In 1834 he succeeded Boyer at the Surgical Clinic in the Charité—a place which he filled with the highest distinction for 33 years. As an operator, his fame became world-wide. He died Aug. 18, 1867.

Besides his books and articles (which were mostly of the highest character) on general surgery, he composed a number of ophthalmologic writings, of which the following are the more important: 1. *Du Strabisme*. (Paris, 1842.) 2. *Manuel Pratique des Maladies des Yeux, d'Après les Leçons Clin. de M. le Prof. Velpeau*. (Paris, 1840.) 3. *Leçons Orales de Clinique Chirurg. Faites à l'Hôpital de la Charité, p. par V. Pavillon et G. Jeanselme*. (3 vols., Paris, 1840-41.)—(T. H. S.)

Venæ vorticosæ. VORTEX VEINS. See p. 389, Vol. I and the illustrations on pp. 405, 406 and 408 of this *Encyclopedia*.

Venarsen. A proprietary name for a compound of sodium dimethylarsenate. This agent has been used with good results in syphilis. In this combination 0.7 gm. (10.8 grs.) of sodium dimethylarsenate salt is combined with about 1/40 grain mercury iodide, and a small amount of sodium iodide. The mercury and the iodide are believed to prevent the sensitization of the spirocheta pallida. Dose—5 cc. (one ampoule) or less intravenously. There is also a double strength ampoule. See, also, **Sodium cacodylate**, for an opinion as to the comparative therapeutic value of this mixture.

Vencalxodine. The trade name of a sterile solution (sold in ampoules for intravenous injection) representing calcium iodide, 10 grains, iodide $\frac{1}{4}$ grain and guaiacol for its antiseptic effect, for the treatment of tuberculosis. The average patient will take this product without reactions or other ill effects. Dose—20 cc. (one ampoule) or less.

Venerisches Geschwür. (G.) Chancre.

Venesection. PHLEBOTOMY. General blood-letting. See p. 1226, Vol. II of this *Encyclopedia*.

Vengut. See **Grapheus**.

Vennemann, Emile. A well known professor of ophthalmology at the University of Louvain. He was born in 1851, and died suddenly of heart disease in 1897.—(T. H. S.)

Venomer. The trade name of a substitute for salvarsan, to be used intravenously. It is a sterile product containing in each 5 cc. solution .016 gm. ($\frac{1}{4}$ gr.) mercury iodide, .260 gm. (4 grs.) sodium iodide, .065 gm. (1 gr.) sodium dimethylarsenate, in a vehicle for intravenous administration. Dose—5 cc. or less.

Venosal. The trade name of a product for intravenous use. The composition is sodium salicylate, 15.4 grs. (1 gm.), iron salicylate a minute quantity, and the equivalent of approximately 2 grs. of dried colchicum root. Venosal has been used in rheumatism, tonsilitis and other streptococcic infections. Dose—20 cc. (one ampoule) or less.

Venous retinal pulsation. See p. 10530, Vol. XIV of this *Encyclopedia*.

Venous retinal thrombosis. See p. 1962, Vol. III of this *Encyclopedia*. See, also, **Thrombosis**.

Ventouse de Heurteloup. (F.) The (artificial) leach of Heurteloup.

Ventouseuration. (F.) Cupping.

Ventricles, Tumors of the. The ocular signs of cerebro-ventricular tumor have to some extent already been discussed in this *Encyclopedia*. See, e. g., p. 2086, Vol. III, and on p. 1274, Vol. II.

In the paper of Lewis J. Pollock (*Journ. Am. Med. Assocn.*, p. 1903, June 5, 1915) he summarizes the essay of T. H. Weisenburg (*Brain*, p. 236, Vol. 33, 1910) who distinguishes the following three groups: 1. Those cases in which a tumor of a moderate size is situated in the floor of the third ventricle, and in which there is no extension into the foramen of Monro or aqueduct of Sylvius. 2. Small tumors so situated as to obstruct the foramen of Monro and whose position can be changed by deviation of the head. 3. Those tumors, whether large or small, which either extend into the aqueduct of Sylvius, affecting the surrounding structures by direct extension or pressure, or those in which the posterior portions of the cerebral peduncles and pons are compressed, either by direct pressure or by dilatation of the aqueduct of Sylvius.

The first class does not offer specific symptoms, but presents evidences of internal hydrocephalus, namely, headache, choked disk, nausea, vomiting and dizziness. In tumors of large size, indirect pressure on the internal capsule causes paresis of the corresponding limbs. These symptoms may likewise result from internal hydrocephalus alone. The reflexes are nearly always increased. The mental symptoms, generally supposed to be present in tumors of the third

ventricle, are attributed by Mott (*Arch. Neurol.*, i, p. 417, 1900) to the impairment of the function of the cortex as the result of the pressure of the dilated ventricles.

The second class is unimportant as but one case has been observed. This group presents a variation in symptoms of headache, nausea and impairment of vision on tilting the head forward.

The third class offers a fairly well recognizable syndrome. The symptoms arise from involvement of the third nuclei, red nucleus, or superior cerebellar peduncles and from pressure on, or destruction of, the posterior longitudinal bundle or the intercommunicating fibers between the third nuclei. Among the symptoms noted are disturbance of associated ocular movements, oculomotor palsies, large pupils with impaired reaction, protrusion of the eyeballs, cerebellar ataxia, symptoms arising from pressure on the pineal gland and the general symptoms of tumor cerebri.

One of Pollock's cases presented the following symptoms: Boy, 14 years old, with rather precocious genital and hairy development suggesting hyperpinealism. Limitation of ocular movements. Papillitis and blindness. Ataxia. Headache; drowsiness; mental dulness. Soft glioma filling third ventricle; secondary hydrocephalus.

Peter Bassoe (*Journ. Am. Med. Assocn.*, p. 1423, Nov. 11, 1916) in a comprehensive and illustrated paper on tumors of the *third and fourth ventricles* remarks that neoplasms arising from the latter site are much more common than those of the third ventricle. They also produce symptoms by inducing hydrocephalus and by exerting pressure on neighboring structures, in this case the cerebellum, pons and medulla. Like all other posterior fossa tumors, they may produce stiffness of the neck and occipital pain; and as increase in cells and globulin as well as in the pressure of the spinal fluid is common, a clinical resemblance to meningitis sometimes exists. This was shown in one case, while another presented the picture of cerebellar tumor, and in two others mental symptoms predominated. In another case reported by the writer in which, in addition to the fourth ventricle tumor, another ependymal glioma in the frontal lobes was present, mental symptoms entirely dominated the clinical picture. Sudden death is very frequent in these cases. The majority showed various degrees of *papilledema* and *ophthalmoplegia*.

Verant. A stereoscope for monocular vision which has been introduced by Zeiss.

Veratrin. This remedy is an alkaloid (or rather a mixture of alkaloids) obtained from the seeds of *Asagrea officinalis* and other plants. It is a grayish-white, odorless, amorphous agent with an acrid taste

that leaves a numb feeling in the mouth and sets up violent sneezing if even a minute particle reaches the nose. It dissolves in 1,750 parts of water and is very soluble in alcohol, ether and chloroform.

This powerful alkaloid is occasionally useful in the form of the ointment (U. S. one per cent.) when applied for the relief of ocular neuralgia. Coccius used it to relieve the pain of iritis as a one or two per cent. mixture with vaseline. A piece the size of a pea should be placed on a piece of cotton and rubbed along the course of the affected nerve. This may be repeated two or three times daily if required. Toxic symptoms have followed even this mild inunction, so that great care should be observed in using so poisonous an agent.

Theobald (*Text-book*, p. 505) prefers the oleate in 10 per cent. strength to any other preparation of the kind in asthenopia and frontal headache due to accommodative strain. He also employs it to lessen the irritability of the ciliary muscle preparatory to testing errors of refraction. A little is to be rubbed upon the forehead and temples once a day, preferably in the morning. None of it should be allowed to enter the eye, as it causes severe and persistent irritation. See, also, **Hellebore**.

Verbal amnesia. See **Word-blindness**, as well as p. 326, Vol. I of this *Encyclopedia*. Ingegnieros reports a case in which with complete cortical hemianopsia the patient was supposed to be unable to recognize any color in any part of the field of vision. Close investigation showed that this was due to verbal amnesia, inability to name the colors shown. His color perception and fields were found to be normal.

Verbinden. (G.) Bandaging.

Verbrennung. (G.) Cauterization.

Verdunkelung. (G.) Obscurity (of vision).

Verfettung. (G.) Fatty metamorphosis.

Vergence. An (oculomuscular) movement of convergence, divergence, or sursumvergence of the eyes. See **Prism verger**, p. 10383, Vol. XIII of this *Encyclopedia*.

Verger, Prism. See **Prism verger**, p. 10383, Vol. XIII of this *Encyclopedia*.

Vergrössern. (G.) To enlarge.

Verifications of symptoms are reports of homeopathic cures; they form an essential part of the system of homeopathy, but they must be properly reported. Every clinical report should be so clear and full that the reader or hearer will not only agree with the reporter in the diagnosis but will concede that the cure or relief claimed is *properly attributable to the remedy* and to nothing else. This requires of

course the administration of but one remedy at a time. Care should be taken to mention all adjuvant treatment and other change in environment, the duration of the symptom or disease and also the promptness and permanence of the relief. The symptoms which led to the selection of the remedy should be emphasized. See **Homoeopathy in ophthalmology**.—(J. L. M.)

Verletzung. (G.) Wound; injury.

Vermale, Raymond de. A celebrated French surgeon of the 18th century, renowned for his recommendation of the double-flap amputation. He was for a time surgeon-in-chief to the Electorate of the Palatinate, and was Corresponding Fellow of the Royal Academy of Surgery. His only ophthalmologic writing was "*Lettre sur l'Extraction du Cristallin hors du Globe du l'Oeil, Nouvelle Opération Imaginée par le Célèbre M. Daviel.*" (Paris, 1751.)—(T. H. S.)

Vermes, Eyes of. See **Worms, Eyes of.**

Vermiform movements of the pupil. See **Pupil**, p. 10795, Vol. XIV of this *Encyclopædia*.

Vermögen. (G.) Power.

Vernyne, J. J. B. A well known ophthalmologist of New Bedford, Mass. Born in Holland in 1835, he became a surgeon in the Dutch navy. While on duty at Surinam, he married the daughter of a merchant of New Bedford, Mass. Returning to Holland, the doctor entered upon general practice, but, the Franco-Prussian war breaking out, both he and his wife joined the Red Cross Society and served as members of that body throughout the war. Because of his merit as surgeon the French Government conferred on him the order of the Legion of Honor. Removing to New Bedford, Mass., he engaged at first in general practice. Turning his attention, however, to ophthalmology and otology, he soon had a wide reputation. In 1873 he became a member of the American Ophthalmological, and in 1875 of the American Otological Society. He was one of the founders of St. Luke's Hospital, New Bedford. His chief recreations were music, painting and poetry. He was a warm-hearted, companionable man, and had large numbers of friends. He died in 1898, at his summer residence, Francetown, New Hampshire, aged 63.—(T. H. S.)

Vernal conjunctivitis. SPRING CATARRH. PHLYCTENA PALLIDA (Hirschberg). FRUEHJAHRSCATARRH. PERIODIC PLASTIC CONJUNCTIVITIS. SCLERO-CORNEAL FIBROMA. CONJUNCTIVITIS LYMPHATICA (Arlt). VERNAL CATARRH. CONJUNCTIVITIS CATARRHALIS ÆSTIVA. SAEMISH CATARRH. SPRING CONJUNCTIVITIS. In addition to the matter given on p. 3170, Vol. V—in which this subject is brought up to 1912—it is here proposed to continue the discussion of it to date.

During the spring and summer of the previous four years, a child of 11 years was observed by Casey Wood (*Prac. Med. Series, Eye*, p. 32, 1908) to have the symptoms of vernal conjunctivitis in her left eye. Recently horny growths were observed on the left upper lid and there was a decided ptosis. Some of the growths were subjected to microscopic examination by T. A. Dagg, pathologist to St. Luke's Hospital. He reported a chronic hyperplasia of the epithelium (see the figure) and underlying connective tissue, and that the process



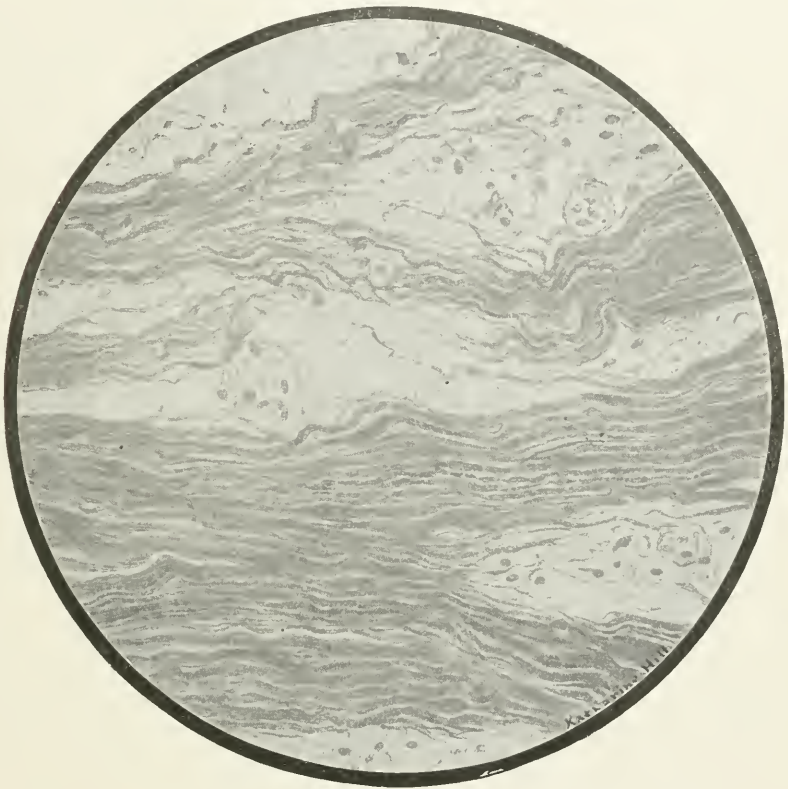
Palpebral Vernal Catarrh, Showing Trifoliate Epithelial Growths. (Casey Wood.)

was of an inflammatory nature, as indicated by the amount of round-cell infiltration. (See the second illustration.) The diseased parts were exposed daily for six weeks to the X-rays after the plan of Frank Allport and W. A. Pusey. See p. 3177, Vol. V of this *Encyclopedia*. The patient was relieved of all her symptoms and the clinical appearances of the lids vastly improved.

Brown Pusey (*Journ. Am. Med. Assoc'n.*, Oct. 7, 1911) again refers to his examination of smears from cases of vernal catarrh. He says that he has found *eosinophil polymorphonuclear leucocytes* in great abundance in a series of cases of *hay fever*; indeed the cellular content of a smear from the one disease is the same as that from the other. Hence he thinks that the presence of eosinophil cells in the conjunctivitis of hay fever and in vernal catarrh, and their absence in ordinary forms of conjunctivitis, point strongly to a similar etiologic factor—pollens.

George Swift (*Ophthalmic Record*, Dec. 1915) recommends that

5 per cent. dionin solution be dropped into the eyes three times a day in cases of spring catarrh. The primary reaction caused by the remedy he characterizes as "terrific." The itching, the drooping of the eyelids, and the dullness of the cornea readily respond to dionin, but the result as regards the conjunctival lesions is not so pronounced.



Unilateral Palpebral Vernal Catarrh.

Section of hyperplastic papule stained by Weigert's method to show the elastic tissue. (Casey Wood.)

Dunbar Roy (*Southern Med. Jour.*, October, 1915; abst. *Am. Journ. of Ophthalm.*, p. 31, 1916) remarks that his interest in the past had been aroused by a peculiar form of conjunctival inflammation occurring in *negroes* which did not conform to the types of trouble familiar to him. After a systematic study he was convinced that the disease observed by him is vernal catarrh. In the last ten years he has seen 100 cases and they have shown a characteristic composite group of symptoms. The atypical cases were ruled out. The typical case was

of the bulbar type. The ages varied from 3 years to 26 years, the majority being between 6 and 12. As to sex, the cases were equally divided. Most of the patients had had the disease for from two to five years. The subjective symptoms were photophobia, a heavy feeling, burning and gritty sensation about the lids. The discomfort was not, however, great. The objective symptoms were congestion of both bulbar and palpebral conjunctivæ with some signs of catarrhal discharge. The changes in the palpebral conjunctiva were limited to congestion. At the limbus there was an elevated circular waxy and gelatinous mass, extending from one-half to even four millimeters on to the cornea and was widest at the upper and lower margins of the cornea. There was an occasional pigmentation at the conjunctival edge of the hyperplasia. The hyperplasia was proven to be in every case virtually a part of the cornea itself, as it could not be separated without cutting or shaving it. Specimens were examined microscopically and a summary of the principal alterations were: (1) Localized thinning of the surface layer of epithelium, the swelling and vacuolization of many of these elements, the presence of eosinophile cells between these elements. (2) The projection downward into the deeper structures, of club-shaped columns of epithelium containing usually more or less centrally located cavities. (3) The presence in these cells of peculiar bodies which may be the result of degeneration of these bodies or possibly parasites. (4) The presence between these columns of enormous numbers of plasma and lymphoid cells, quite a number of eosinophile cells and some newly-formed fibrous tissue.

In discussing the diagnosis Roy states that he has never seen a single case of trachoma in the negro, this latter disease being frequently confounded with vernal catarrh. Stress is laid on the finding of eosinophiles. Roy's cases recurred and persisted during the warm months and he contends emphatically against the dictum of Bruns that such cases are examples of phlyctenular conjunctivitis.

Butler (*Oph. Year-Book*, p. 97, 1916) gives two cases of vernal conjunctivitis treated with radium. The first patient had, before coming into Butler's hands, been treated mechanically and medicinally for trachoma. There was argyrosis; and cicatrices from the operation. The palpebral conjunctiva exhibited tessellated granulations and there were marginal hypertrophies. The conjunctival secretion contained eosinophils. Treatment by exclusion of air and direct light was unsuccessful. He was then treated by Mackenzie-Davidson with 45 mg. of radium bromid for four minutes. This was repeated in three weeks. The result was, on the whole, satisfactory. In the second case the characteristic changes were confined to the margin of the cornea.

The conjunctiva had a milky hue and eosinophils were present in the secretion. Applications of two plaques carrying 7 mg. each of radium bromid were made, ranging from 8 to 15 minutes. The last treatment was in August and by the following July all subjective and objective symptoms had disappeared. Davidson states that all of the cases he has treated have been completely cured. There persists, however, in some cases a certain degree of irritation, but the characteristic phenomena never return. He considers it a specific.

The treatment of *Spring catarrh by radium* has also been carried out successfully by J. M. Simon de Guilleuma (*La Clinique Ophtal.*, Dec., 1918; review *Br. Journ. Ophthalm.*, p. 279, June, 1919). Encouraged by the success of Schaudigel and of Harrison Butler with radium, the author decided to try the radium ion. He used a forceps like Desmarres', one blade of which carries a pad of cotton to contain the electrolyte. The pad rests on a platinum plate and there was the necessary electric connection. The electrolyte is a solution of bromide of radium in the strength of one microgramme (millionth of a gramme) to the cubic centimetre. Leaving out the minute details, which any one wishing to use the method may study in the original, the author employs a current worked up very gradually from zero to 1 milliampere, this for ten minutes, and then an equally gradual descent to zero. In the case recorded, twelve sittings were given in forty-nine days. The patient remained completely cured for two spring seasons.

A complete account of *vernal conjunctivitis* is given by Edward Jackson (*Amer. Jour. Ophthalm.*, April, 1918).

The writer deals with the aspects of the disease which should lead to recognition and appropriate management. It is based on forty-four cases, notes of which have been taken in Denver in the last fifteen years. Ten years' previous acquaintance with the disease in Philadelphia seemed to indicate that it is more common in the dry, elevated region of the Western United States.

"Of individual symptoms the pericorneal hypertrophy first attracted attention in this country, giving its title to the article of Burnett. It is not constant. In a few cases it is very striking, forming a thick mass unmistakably pathologic, and sometimes extending entirely around the cornea. More often it only involves part of the limbus, the temporal or the nasal portion by preference; but sometimes involves other parts even though the temporal and nasal regions are free from it.

"It becomes hyperemic and thicker during the warm part of the year; but if at all marked it disappears very slowly. It is composed

of dense, opaque fibrous tissue, as well as thickened epithelium; and has a slightly wavy or irregular inner border rising abruptly from the cornea. This thickening was present in fourteen of the twenty-three cases that showed lesions of the eyeball. It was first emphasized and studied by Reymond."

The cornea itself is rarely involved, but in two of the writer's cases this occurred.

Hyperemia of the palpebral conjunctiva is present in the majority of cases, and is always found in those of recent origin. In the more severe and chronic cases it may be absent, or masked by other changes in the lid. It tends at first to be uniform over the whole inner surface of the lid, and to assume a slightly purplish-red color.

The gray film on the palpebral conjunctiva, which has often been compared to a thin layer of milk upon the surface, was first emphasized and described in detail from Horner's Clinic by Vetch (*Inaug. Dis., Zurich, 1879*). It varies from an unmistakable hiding of the deeper tissues to the slightest veiling perceptible against a uniform, rather purplish background of hyperemia. It is not constantly present, according to Jackson's experience, and was noted in but seventeen of his cases.

Roughening of the inner surface of the lids was present in but twenty-eight of the forty-four cases. It is of two kinds. More common, is slight irregularity such as might be due to slightly enlarged papillæ and noted as "papillary." In the second form are larger protruding masses often with a contracted neck or pedicle, which have sometimes been compared to the circumvallate papillæ of the tongue, and sometimes to a cobblestone pavement. When very numerous these become irregularly hexagonal by mutual pressure. They are of slow development, may continue with little change from year to year, and are of firm consistence. They are never soft and dark-red, like the masses sometimes seen late in gonococcus ophthalmia; but rather pale-yellowish, and of even cartilaginous consistence. Such granulations were present in fourteen cases. They may remain but little altered for many years, and cases presenting them have generally been regarded by some who treated them as examples of trachoma.

Noticeable discharge is not always present; but it is often a persistent and most annoying symptom. It was observed in fourteen cases, generally when there were large masses of hypertrophy on the palpebral conjunctiva. It is described as stringy, adhesive, always consistent, sometimes even in cheesy masses. Rarely, if ever, it is thin

and watery. It may be almost colorless, but is more often a yellowish-white color.

The subjective symptoms are generally slight and unimportant except the form of irritation that is usually described as "itching," and often causes a strong inclination to rub the lids. Itching was especially noted in nineteen cases.

The annoyance from the strings of discharge which form and are difficult to get rid of, is a frequent cause of complaint. Photophobia may be annoying, but sometimes is not noticed. But the eyes feel "weak" and there is a strong disposition to avoid their use.

Two points that have an important bearing on the diagnosis are the season of the year at which the attacks appear, or become aggravated; and the age of the patient. With reference to the seasonal prevalence of the disease, Jackson's patients first applied for relief as follows:

January	1	July	3
February	1	August	5
March	5	September	5
April	6	October	4
May	5	November	0
June	9	December	0

The patient seen in January was not suffering at the time, but said that for many years his eyes "had looked like a beefsteak from August until frost." The patient seen in February had suffered from the trouble for years, and, like some of those seen in March, sought to forestall a new attack. Of the patients seen in October, two had suffered from the trouble for years, and two had been much worse during the spring and summer. No case seemed to arise between September and March.

As to sex, the writer finds that twenty-five of the patients were males, nineteen females, a preponderance of the former that might easily be accounted for by more general exposure to light and dust. With reference to the age of the patients: At the time of the first attack the best obtainable history indicated that it was:—

Under 5 years	3
5 to 10 years	15
10 to 20 years	13
20 to 30 years	9
30 to 40 years	2

The repetition of the attack or exacerbation each summer commonly goes on for several years. Only eight patients were seen in the year of the first attack. Most of them were not cured when last seen, but the attacks had continued to recur:

Less than 5 years	19
5 to 10 years	13
10 to 15 years	4
15 to 20 years	6
Over 20 years	2

Regarding the very important matter of diagnosis, most cases of vernal conjunctivitis have at some time been mistaken for trachoma, and trachoma is such a varied, multiform disease that there is reason for liability to this error. Both trachoma and vernal conjunctivitis are inflammations affecting the conjunctivas of the lid and globe, and running a course measured in years. Both are marked by swelling spoken of as "granulations" on the palpebral conjunctiva, and possible extensions of the lesions on to the cornea. But with these points of similarity there are others of essential difference that will lead to a correct diagnosis if they are borne in mind and looked for.

Trachoma begins insidiously, becoming manifest at any time of year. Vernal conjunctivitis begins with a fairly distinct exacerbation in the spring or during hot weather. The relapses or recurrences of trachoma arise at any season, following ordinary conjunctival irritants. Those of vernal conjunctivitis are closely related to warm weather. The granulations of trachoma are deeply situated in the conjunctiva, or beneath it in the deeper tissues. Those of vernal conjunctivitis arise on the surface, and extend out from the normal surface, being often slightly pedicled. In trachoma they are apt to involve the retrotarsal folds. In vernal conjunctivitis they are almost exclusively situated on the tarsal portion of the upper lid, being most developed near the posterior edge of the tarsus. The skim-milk film of vernal conjunctivitis is not seen on the lid in trachoma, nor are the scarred lids, or altered tarsus of trachoma, seen in vernal conjunctivitis, unless caused by improper treatment.

In vernal conjunctivitis the involvement at the corneal margin consists in a thickening of the limbus, most likely to be marked at the temporal or nasal portion. If other parts of the cornea are involved they present slight irregularity of surface, and non-vascular general haziness. In trachoma the usual corneal lesion is a clouding and superficial vascularity affecting the upper and lower portions of the cornea, those that come most constantly in contact with the lids.

In trachoma the discharge is proportioned to the acuteness of the process, or depends on intercurrent inflammations. In vernal conjunctivitis the discharge is proportioned to the size of the granulations and has a peculiar character. It is stringy, ropy, even almost cheesy in consistence, rather than purulent. In trachoma, microscopic examinations may show the inclusion bodies, or the microorganisms of various forms of infectious conjunctivitis. In vernal conjunctivitis overgrowth of epithelium sometimes arranged like a papilloma, and increase of eosinophiles are the characteristic changes.

As to confusion with other conditions such as tuberculous conjunctivitis, Parinaud's conjunctivitis, chronic diplobacillus conjunctivitis, etc., any mistake of diagnosis will be easily avoided if the clinical characteristics of vernal conjunctivitis are borne in mind and the history of the case is considered.

The correct diagnosis of vernal conjunctivitis is of practical importance because of the totally different line of treatment that should be pursued for it, from what is commonly required for trachoma, or the other conditions with which it is likely to be confused. For the latter, painful and irritating applications and serious operations are appropriate; but for vernal conjunctivitis the only operative treatment indicated is the excision of any large masses found on the tarsal conjunctiva of the upper lid.

Local applications should generally be relatively mild or soothing. Solutions of tannin or ichthyol, one per cent. or less; one per cent. ointment of the yellow oxide of mercury, solutions of boric acid, three per cent.; sodium hyposulphite or potassium chlorate, one per cent. or less, or quite weak solutions of adrenalin are to be used. These relatively mild applications contribute to the comfort of the patient and do quite as much toward shortening the course of the disease as any more active and painful line of treatment.

Probably for a radical cure, where such treatment is available, repeated exposures to the Roentgen-ray or to radium, are our most valuable therapeutic measures. With reference to the latter, Allport states that of at least fifteen patients treated with X-ray exposures in a dozen years "they have all been cured, that is, all who have carried the treatment through to the end."

Butler has obtained equally conclusive results through applications of radium, and Mackenzie-Davidson, who applied the treatment for him, states that all of the patients whom he had treated thus "have been completely cured."

For prophylaxis or the prevention of recurrences, residence in a cool, moist climate during the hot portion of the year has proven

reliable. Such a climate is found on the coast of Maine, among the lakes of Canada and the northern United States, and in the region of Puget Sound or Alaska. It may be found in some mountain climates, but apparently it is quite as important to avoid dryness of the atmosphere as to avoid heat.

W. A. Pusey (*Journ. Amer. Med. Ass'n.*, Sept. 7, 1918) has *treated with Roentgen-rays or radium several cases of vernal conjunctivitis*. The results with either agent seem to be the same, the application of radium to the inner surface of the eyelids is so much less difficult than that of Roentgen-rays that in the last few years he has used only radium.

The lid to be treated is everted and held in the everted position by clamping lightly with lid forceps. The blade next to the eye is of solid heavy metal, so that it prevents the eye itself being reached by an appreciable amount of rays. The outer blade consists of a rim with a large opening which leaves exposed the area of conjunctiva for the application of the radium. The writer has used in these cases a flat radium applicator containing in varnish 5 mg. of radium element. This applicator is of sufficient strength to produce a bright erythema on normal skin by an application of ten minutes through thin rubber cloth.

In order to avoid discomfort, he does not make any pressure in applying the radium to the lid, but passes it back and forth over the lid just short of the point of contact with the surface. He estimates that in an application to the whole palpebral conjunctiva with the applicator moving about, each part of the surface of the conjunctiva gets an exposure of one-third; that is, with an application of thirty minutes, the applicator being moved back and forth, each part of the lid gets an exposure of ten minutes. He prefers to make the application in broken doses of five minutes' duration over the whole lid for six successive days, so that in the course of a week the conjunctiva gets thirty minutes of a moving exposure, each part of the lid thus getting ten minutes. This exposure with W. A. Pusey's applicator has not proved sufficient to give any evidence of Röntgen-ray reaction. After such treatment, the patient is usually allowed an interval of several months, depending on the condition of the conjunctivitis. Usually the first series of treatments is followed by distinct improvement. In one successful case, Pusey gave four series of such exposures in the course of a year without at any time producing an apparent radium reaction in the case, but obtaining a completely successful symptomatic result.

The number of cases treated is not sufficient to warrant any dog-

matic statements, but all have been cases of severe vernal conjunctivitis, with papillomatous thickening of the conjunctiva, with characteristic grayish pellicle, and with extreme photophobia. They have been of many years' duration, and resisted previous competent treatment with other remedies. The results have been successful to a noteworthy degree; indeed, they have been so gratifying in these otherwise entirely intractable cases, and the treatment is so easy, that the method seems worthy of wider application than it has received.

Vernes colorimeter test. Preiswerk (*Schw. Med. Wochenschr.*, Jan. 15, 1920) applied the Vernes technic for the detection of syphilis in 1,200 cases and obtained parallel results to the Wassermann test in 76.7 per cent.; totally contradictory results in 1.1 per cent., and slighter divergence in the others. The technic is comparatively simple and easy, but the ingredients are not so constant as Vernes claims. Fresh pig serum is used instead of the rabbit amboceptor, and guinea-pig hemolysis is determined with a color scale. The organ extract is made with ethylene tetra chlorid acting on desiccated myocardium tissue from the horse.

Vernisol. A skin varnish, soluble in water in the form of a jelly which dries and leaves a transparent, flexible coating, non-irritating. It is a satisfactory substitute for collodion and may be medicated.

Vernon, Bowater J. A London ophthalmologist. Born in 1837, he became assistant at Moorfields in 1864 and later curator of the Moorfields Museum. In 1867 he was made demonstrator for eye diseases at St. Bartholomew's Hospital, and two years thereafter surgeon at the Eye Division of this institution. The most of his writings appear in the *St. Bartholomew Hospital Reports*. Vernon died in 1901.—(T. H. S.)

Veronal. This proprietary remedy is now known as *barbital*. See report of National Research Council (*Am. Journal of Ophthal.*, p. 536, July, 1918). It is a white powder derived from urea—a diethyl-malonylurea. In 5—10 grain doses it is a valuable hypnotic.

Verre. (F.) Glass.

Verres à double foyer. (F.) Glasses with a double focus.

Verruca. WART. PAPILLOMA. This growth is a benign elevation of the skin (sometimes of the mucous membrane) chiefly formed of hypertrophies of normal papillæ. This growth is occasionally seen upon the eyelids. The most common form in this locality is the so-called filiform variety, which is chiefly found in old persons (*verruca senilis* or *keratoma senile*).

Since a palpebral wart is liable to degenerate into rodent ulcer or epithelioma it is always advisable to remove it by means of acids,

caustics, or surgical means, the best of which last is electrolysis.—(J. M. B.) See, also, **Papilloma**, p. 9241, Vol. XII of this *Encyclopedia*.

Verrucosities of the lamina vitrea. See **Drüsen**, p. 4084, Vol. VI of this *Encyclopedia*.

Verrucosities of the optic-nerve head. See p. 2328, Vol. IV of this *Encyclopedia*.

Versicolored. Variegated; polychromate; of many colors.

Version power. See **Muscles, Ocular**.

Version test. See **Muscles, Ocular**.

Vertebrates, Eyes of. See **Birds, Eyes of**; **Amphibians, Eyes of**; **Mammals, Eyes of**; **Fishes, Eyes of**; **Comparative ophthalmology**; as well as **Embryology of the eye**, in this *Encyclopedia*.

Vertex dioptrimeter.—An optical instrument that has been designed for accurately measuring the dioptral power of any ophthalmic lens in terms of the vertex-dioptry, which is the reciprocal of the focal length measured between the vertex or pole of the lens and its focal point. The instrument consists of a telescope and collimating device, with illuminated target. Facilities for measuring both spherical and cylindrical powers are provided for an entire range of 20D_v. The readings are taken directly from two scales without calculation of any kind. See *Vertex refraction*, under **Lenses and prisms**, p. 7257, Vol X of this *Encyclopedia*.—(C. F. P.)

Vertex of a mirror. The mid-point of a concave mirror.

1

Vertex refraction. The power, V , of a lens, V being equal to $\frac{1}{v}$, in which v , the distance between the lens and the image, is counted from the vertex or pole of the lens instead of from the second principal point. See **Lenses and prisms**, p. 7257, Vol. X of this *Encyclopedia*.—(C. F. P.)

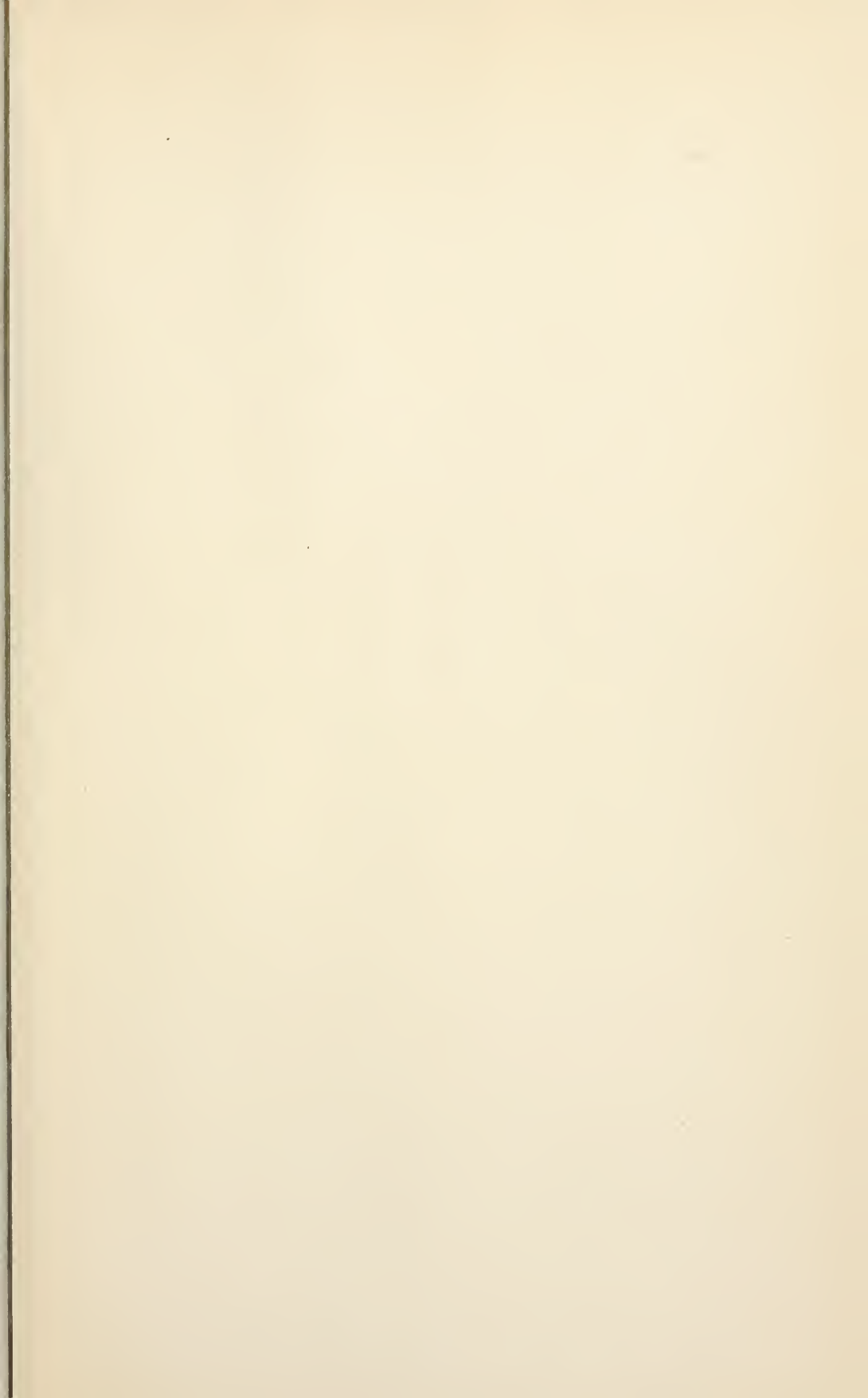
Vertical deviation. The turning up or down (or the tendency so to turn) of one or both eyes. See **Muscles, Ocular**.

Vertical diplopia. Diplopia, in which one image appears higher than the other.

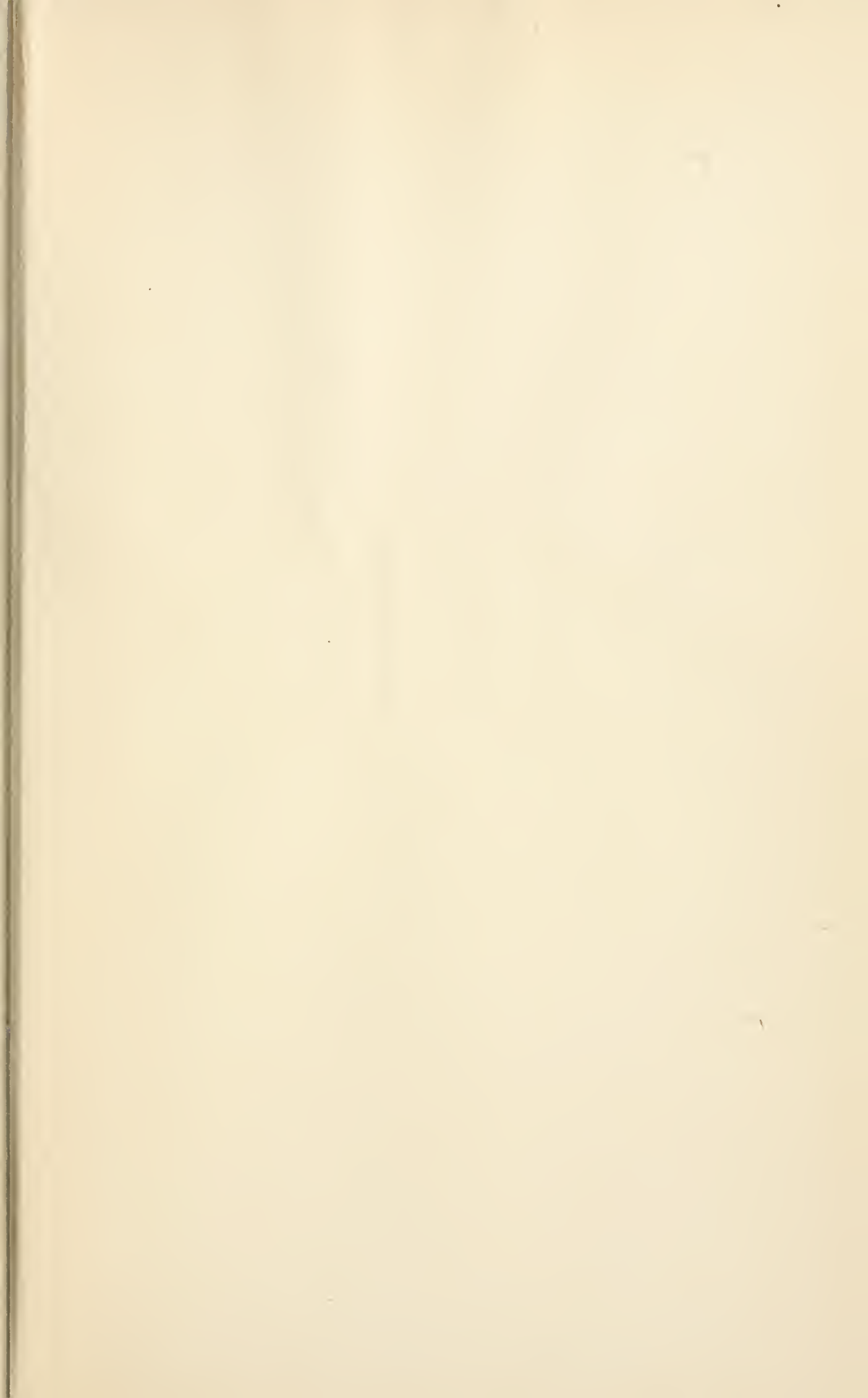
Vertical illuminator. An illuminating device within a microscope, by which light entering the side of the tube above the objective is reflected down upon the subject. See **Smith's vertical illuminator**.

Verticellium graphii. An organism that occasionally affects the cornea. See **Keratomycosis**, p. 6832, Vol. IX of this *Encyclopedia*.

Vertige paralyant. PARALYTIC VERTIGO. See **Gerlier's disease**, p. 5369, Vol. VII of this *Encyclopedia*.







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